REFINING • PETROCHEMICALS • NATURAL GASOLINE

Petroleum Refiner

JANUARY
1958

SPECIAL MAINTENANCE REPORT

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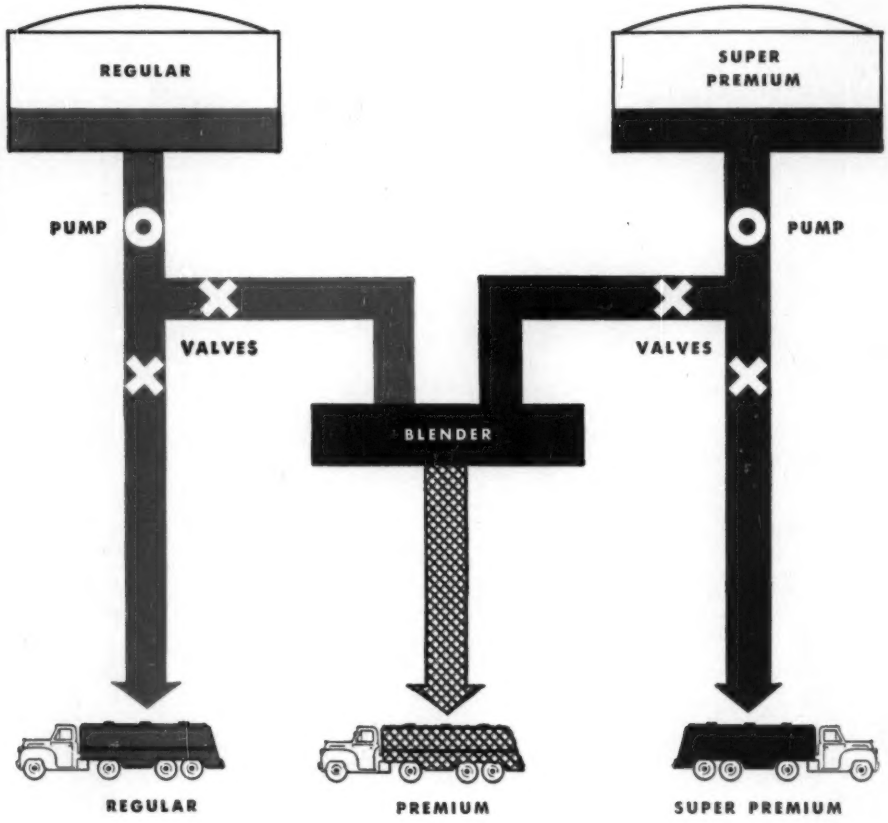

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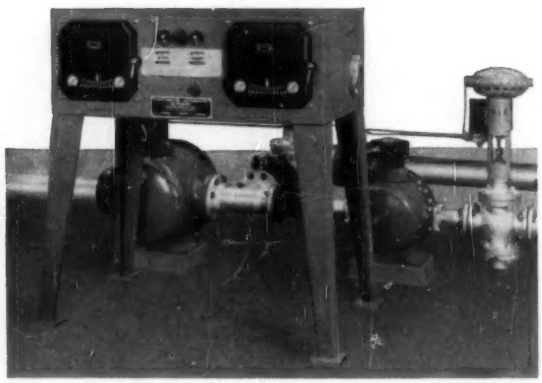

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Petroleum Refiner

REFINING • PETROCHEMICALS • NATURAL GASOLINE

A Quick Look at This Issue

These handy digests permit checking the articles you want to read first. ☑

SPECIAL MAINTENANCE REPORT

☐ **A Foreman Looks At Maintenance . . .** Are you rotating your maintenance jobs the way a foreman would? In an interview, a foreman tells how to rotate jobs to keep up maintenance morale. He also tells how he deals with mechanics who don't like their jobs. Look at this foreman's appraisal of a mechanic's nature and compare with the practices in your plant. Turn to Page 122.

☐ **How Good Design Reduces Maintenance . . .** Whether it's new equipment, a new unit, or a new refinery, good design will reduce subsequent maintenance costs. Here are some tips every designer should consider to make maintenance a quicker, more efficient program. Turn to Page 124.

☐ **Upgrade Your Maintenance Personnel . . .** Careful selection, directed training and systematic upgrading are the essential ingredients of an effective program for development of maintenance wage roll personnel. Such a program is essential for the protection of plant investment today when the responsibility for operational continuity is shifting from production toward maintenance personnel. For complete details, turn to Page 129.

☐ **Models, a New Maintenance Tool . . .** It's not simple, even for the practiced, to build up the necessary mental image of spatial relationships in a modern, complex plant. With models, however, troublesome arrangements are quickly spotted, and improvements suddenly become obvious. For complete details, turn to Page 132.

☐ **Do You Need a Labor-Meter? . . .** If you can measure everything from acceleration to zigzag, why not measure labor performance? Here's a report on how Shell does it with their HOWDIG and COIN systems. Turn to Page 137.

☐ **Design Your Piping to Cut Maintenance Costs . . .** A plant's piping system is designed only once. Maintenance goes on for years. More thought to maintenance during design results in fewer

Please Turn Page ➔

A Quick Look at This Issue . . .

and shorter costly shutdowns. Here are tips that the designer should watch when designing a piping system. Turn to **Page 141.**

☐ **Modernize Your Maintenance Planning . . .** To keep pace with today's changing procedures, a planning system of several years ago must be revised to minimize downtime. Here's how Esso's Bayway refinery has modernized its maintenance planning program. Turn to **Page 147.**

☐ **Planning Electrical Maintenance? . . .** Realistic dollar figures can be placed on preventive maintenance by using this system. The key is the service of electrical equipment at predetermined intervals by a predetermined amount of manpower. The result is reduced costs. For complete details, turn to **Page 149.**

☐ **How Epoxies Can Simplify Maintenance . . .** Epoxy coatings are tough, chemical resistant and resist undercutting by rust. This versatile material can also be used to patch holes in tanks or pipe where flammable vapors are present. For a comparison between epoxies and other coatings, turn to **Page 152.**

☐ **How to Prepare for Chemical Cleaning . . .** The right preparation can insure a better, safer cleaning job, with less downtime for your unit. The three preliminaries are: planning and scheduling, discussion of equipment to be cleaned and arranging for piping to the cleaning equipment. Turn to **Page 155.**

☐ **Why Use Explosion-Proof Electrical Systems? . . .** The obvious answer is to minimize the fire hazard, but the catch is to correctly designate the hazardous area. Here's how Tidewater did it in their new refinery. Turn to **Page 159.**

☐ **Why Prefab Insulation Cuts Costs . . .** From the development of standards to the actual cutting, assembly and application of prefabricated insulation, one of the first considerations is the question of economics. Here are the answers that cover the cost questions related to prefabricated, thermal insulation. Turn to **Page 163.**

☐ **Does Your Meter Need Proving? . . .** Here's a method, developed by the Chinese Petroleum Corporation, that will test your positive displacement meters for accuracy and calibrate tank cars at the same time. The two are more closely related than you may think, since a volumetric proving system may be used on both. For complete details, turn to **Page 167.**

☐ **The Case of the Scaled-Up Reforming Unit...** A carefully engineered chemical cleaning program will result in fewer maintenance problems for your reformers. Here's the story on how an Ohio refinery reduced their cleaning costs from $3000 to $750 and the cleaning time from 5 days to 32 hours. Turn to **Page 170.**

OTHER TECHNICAL FEATURES

☐ **Applied Hydrocarbon Thermodynamics (Part 1) . . .** This is the series you've been waiting for. Before we take you into the applications, we thought you'd like a little refresher on the elements of thermodynamics to brush off a little of the rust. This one covers the basic definitions. See **Page 173.**

☐ **Petrochemicals to Keep Pace in '58 . . .** This review of past production develops trends which are useful in projecting future demands and capacities of all major petrochemicals. These projections can be important in your planning and plant operation. Turn to **Page 179.**

☐ **Guard Against Detonation Hazards . . .** Any plant handling flammable gases may be exposed to a detonation type of explosion. Review this informative article to see when detonation can occur and what steps you can take to prevent its violent effects in your plant. Turn to **Page 185.**

☐ **How Transport Data Accuracy Affects Design . . .** The transport properties most frequently used in process design are thermal conductivities and viscosities. The accuracy of these properties required for pressure drop and heat transfer calculations are discussed. Evaluate your process design data and the accuracy of required results. Another must for your process design notebook. Turn to **Page 191.**

☐ **Cost Comparisons by Capitalized Cost . . .** Capitalized cost offers an exact method without limitations for making cost comparisons. Although it uses infinity as a common denominator for all service lives, the comparisons are correct for limited periods. This article shows how to use this method. Even income tax can be included if desired. Turn to **Page 195.**

☐ **Why Information Research? . . .** The success of oil industry research depends largely on the efficient use of prior knowledge. However, the sources of prior knowledge are rapidly becoming lost in the growing masses of technical information. For a timely, straight-forward discussion of this serious problem, plus a suggested solution, turn to **Page 259.**

☐ **Test Your Income Tax I. Q. . . .** Are you getting full benefit from *all* income tax exemptions? To make sure, test your income tax knowledge with this 11-question "quizzer" prepared by the American Institute of Certified Public Accountants. It may mean money in your pocket. Turn to **Page 264.**

☐ **Personnel Man in Safety . . .** Want to increase your total of "safe" employes? You can, by making better use of application forms to weed out the "accident prone" and "accident repeater." For details on this excellent safety plan, plus a complete description of the personnel man's role in safety, turn to **Page 268.**

Petroleum Refiner

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When No. 2 is No. 1

EVER HEAR THE STORY of how Henry Ford once chose an advertising agency for his expanding company? He let it be known that such a selection was in the wind and, of course, he was beseiged immediately by a dozen or more companies each of which thought they could do a topflight job for him. He heard each representative's pitch, then asked every man to list the No. 1 and No. 2 agencies in the field. Of course each rated his own as No. 1, and, significantly, every one rated another certain agency as No. 2. Needless to say, No. 2 got the job.

A sales manager of a nationally known company which does advertising in technical journals such as ours employed the same scheme recently. And out of 14 men whom he asked to list the No. 1 and No. 2 publications, 13 gave PR the second spot. The only reason it wasn't unanimous is that our own representative, of course, rated PR as No. 1.

Which gave our friend a pretty good idea of the bona fide leader among periodicals in the processing field.

Double Payoff Here

ANOTHER GOOD REASON for getting in the PR author category turned up last month. A man who contributed to our columns several times during 1957 told one of our editors who was out visitin' that "writing for technical publications is just like buying a retirement policy. For example, my present group of articles, I think, will win me enough recognition that later I can supplement my retirement income by writing."

And he's right, of course. Besides, the plan has an added advantage of a retirement policy gained without payment of a premium. In fact, instead of outgo now for premium, it's income which PR happily pays. This gains prestige which in turn, when retirement income needs supplementing, will accomplish just that.

You got a technical topic that you might develop and thus get started on this royal road? If so, let PR hear from you about it.

Talking for Oil

A YEAR AGO Don Lambert of our staff wrote an article for Look Box (PR's "editorial page," see Page 113 this issue) entitled "Oil Cannot Speak—but YOU Can." It was the third of a series on oil industry public relations that went on to win an award in the Jesse Neal national competition for a significant contribution to the industry served.

In each of our issues since, Don has continued this theme under the heading "If Oil Could Speak" wherein the little barrel-like fellow with oil drop head keeps a sayin' the things you should repeat for him on every possible occasion. (See Page 274.)

He's trying his hardest to make a missionary out of every person connected with the oil industry. And what a mighty force it would become if he succeeds in his efforts!

They Come Big for Gulf's New Platformers

The two new 26,000 b/d Platforming® units for Gulf Oil Corporation's Philadelphia refinery called for giant carbon steel towers to handle this large volume. The biggest, a pair of prefractionating columns 106½ feet tall, are said to be the longest ever shipped into Philadelphia in one piece. Built under license from Universal Oil Products Company, the installation will be used for producing high octane gasolines. The general contractor is Procon, Incorporated. Two sets of nine towers were shop-fabricated by Graver. The fabrication of these and other large towers is handled with ease in Graver's nation-wide facilities, always ample to meet the demand for bigger and more efficiently fabricated processing equipment.

GRAVER®

Building for the Future on a Century of Craftsmanship in Steels and Alloys

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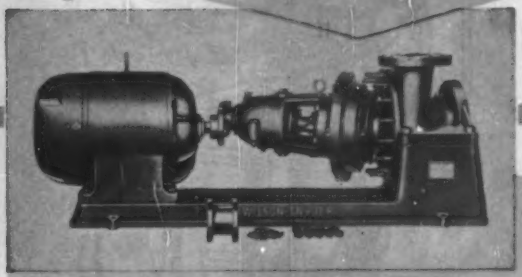
For more data on advertised products, use Readers' Service Cards, last page.

At the All New Yorktown, Va. Refinery of American Oil Company

AMOCO

82 Wilson-Snyder ES Centrifugal Process Pumps... like this



Particularly designed for Processing Services at high temperatures to 900° F., high vapor pressures to 600 psi, and high discharge pressures to 750 psi.

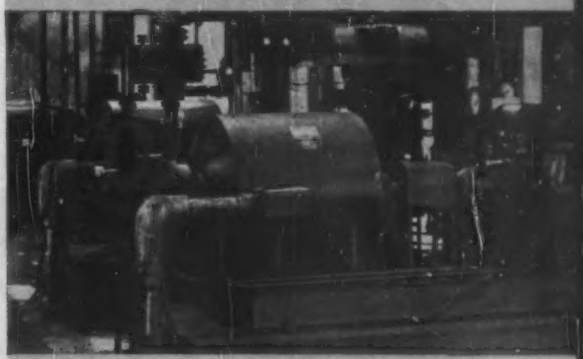
Available in 20 sizes from 15 to 2,000 GPM, 50 to 1,100 foot head, and 2 to 250 horsepower.

...perform a wide variety of processing services!

Very few pumping jobs are exactly alike. Each application involves various combinations of capacities, temperatures, differential heads and liquids with their individual characteristics and material requirements. Typical applications are illustrated here.

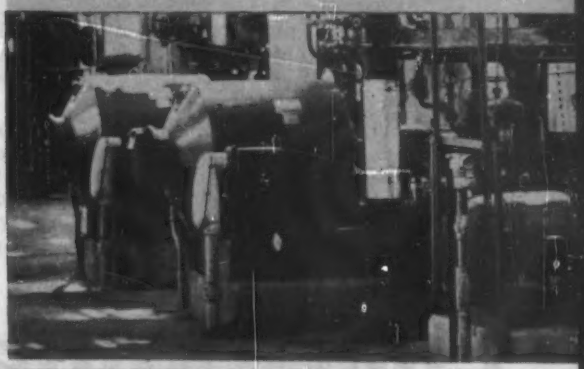
Yet... in addition to the broad capacity, temperature, and head range at high efficiency and the extra long service life that is inherent in Wilson-Snyder Centrifugal Process Pump design . . . a surprisingly small inventory of maintenance parts is required to service all sizes. Only THREE SIZES of bearing bracket assemblies, including shafts, sleeves, bearings and packing need be stocked to service all of the TWENTY pump sizes in the line.

This is why so many users are finding it extremely economical and practical to standardize on these pumps for all requirements within the scope of their application.



These Vacuum Tower Intermediate Reflux Pumps (size 6x8x10½" ES — Top Suction) handle Hot Oil of .672 specific gravity at 550° F. pumping temperature with 318 ft. differential head with capacity range from 1365 to 1570 GPM with 150 HP driving motors.

On the "Cat Cracker" Unit, these pumps (size 3x4x16" ES — Top Suction) handle Low Pressure Distillate of .739 specific gravity at 100° F. pumping temperature with 815 ft. differential head and capacity of 254 GPM with 150 HP driving motors.



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BY CONVERTING
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In addition, LimiTorque protects seats, discs and stems from damage, by automatically shutting-off power source should an obstruction interfere with valve closing. LimiTorque-operated valves are always seated tightly because the valve disc seating thrust is accurately maintained in each closing-cycle, through a micrometer-adjusted torque limiting mechanism.

LimiTorque can be field-mounted on your existing valves—contact your valve manufacturer or nearest LimiTorque sales-engineering office.

Send for complete new Catalog L-550, on your business letterhead.

LimiTorque®

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INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

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For more data on advertised products, use Readers' Service Cards, last page.

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keeps 130,000 BPD efficiently on stream with substantial savings in costs.

because . . .

CONTRACT MAINTENANCE

1. Eliminates idle crews, and made work.
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The use of Catalytic Contract Maintenance results in increased profits.

CATALYTIC
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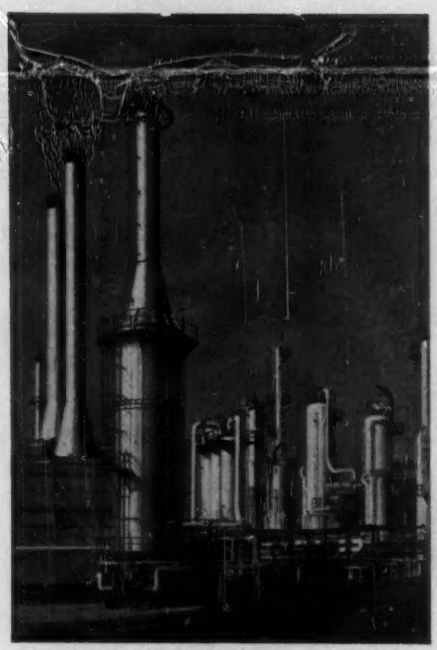


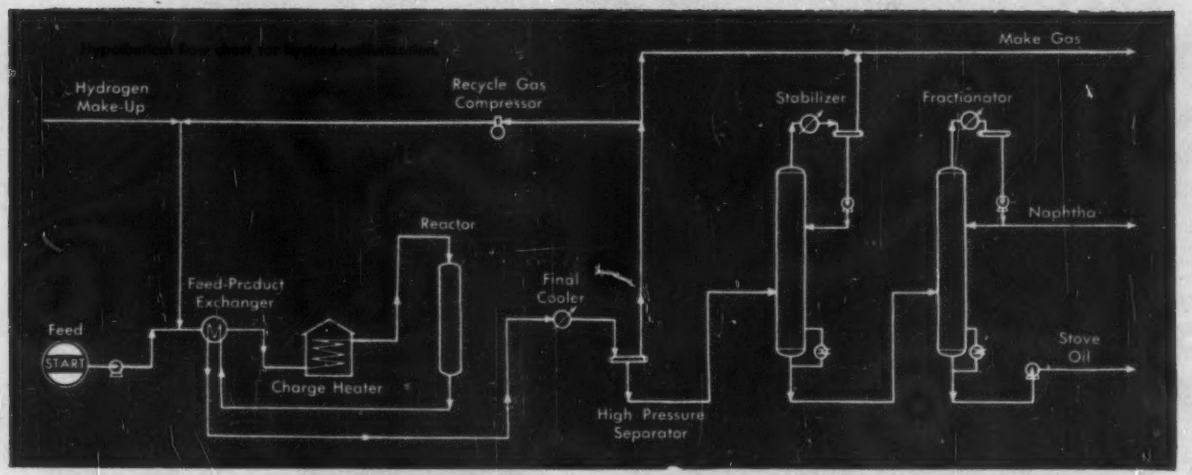
Unifining Unit, Union Oil Company of California refinery, Oleum, California uses Harshaw Cobalt Molybdate Catalyst.

For Hydrodesulfurization

HARSHAW COBALT MOLYBDATE CATALYST

★ **223 regeneration cycles without loss in activity**—a typical performance given by Harshaw Cobalt Molybdate Catalyst, accomplished while treating one of the most difficult charge stocks.

★ **Recording less than 1.0¢/bbl. accumulated costs**—with no indicated loss of activity, Harshaw CO-MO has been full scale tested the longest of any hydrodesulfurization catalyst.



Since you know the critical ingredient of any catalytic hydrogenation reaction is the *catalyst*, the above facts should prompt you to acquire complete details on this premium commodity in the field of catalytic hydrogenation. We shall be happy to point out the many specific advantages that come with using Harshaw Cobalt Molybdate Catalyst and discuss any specific application you may be considering.

Feel free to contact your nearest Harshaw office

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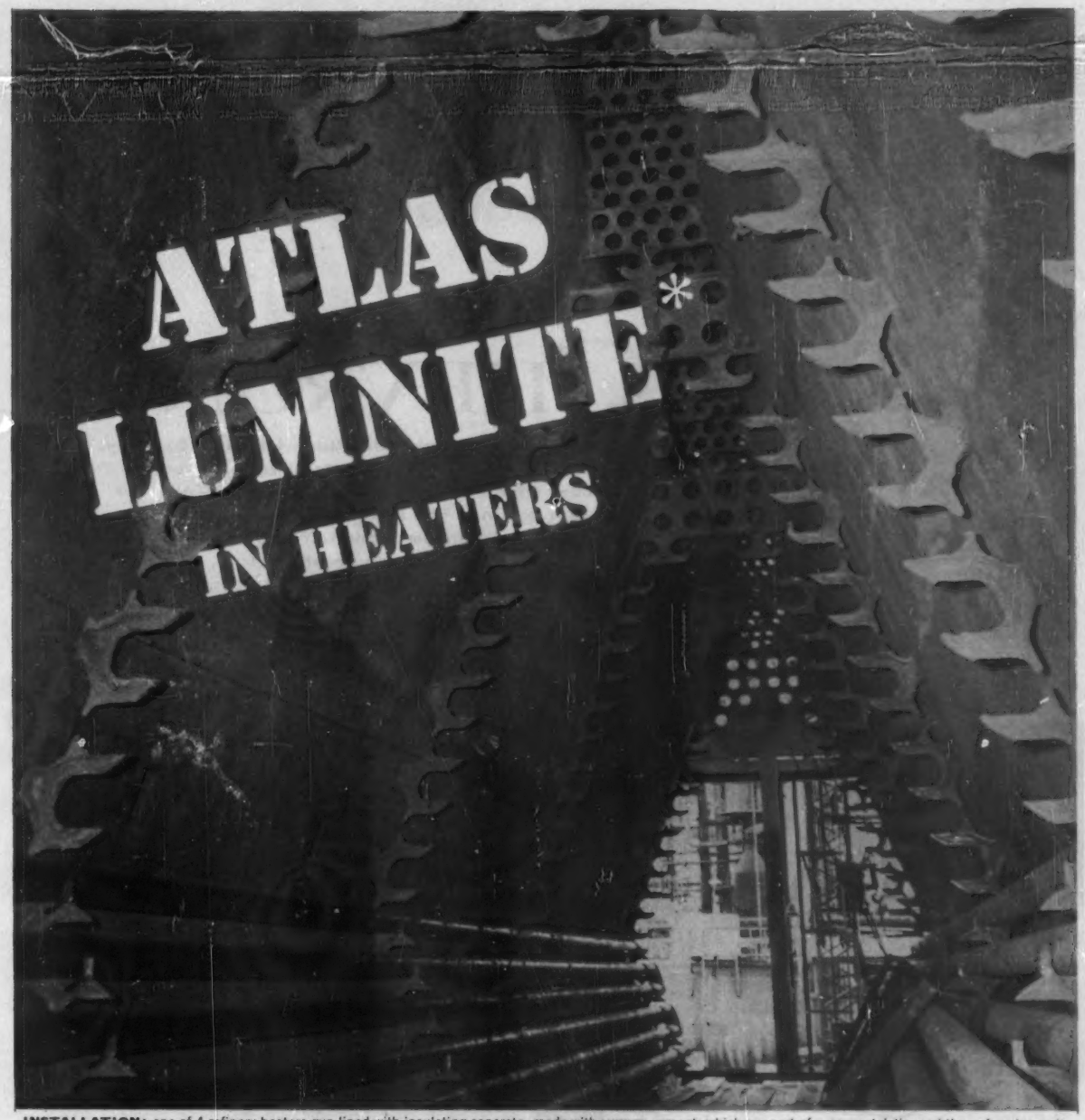

INSTALLATION: one of 4 refinery heaters gun-lined with insulating concrete, made with LUMNITE cement, which are part of a new catalytic naphtha reforming unit. **LOCATION:** The Pure Oil Company, Lemont, Ill. **CONTRACTOR:** The M. W. Kellogg Co., New York. 4 reactors and 6 steel stacks were also lined at this refinery.

- Industrial concrete linings, made with LUMNITE cement and suitable aggregates, resist heat . . . combat corrosion . . . and insulate.
- Production loss due to installation (or repairs) is minimized because placement is fast and easy . . . service strength is reached within 24 hours.
- Improves efficiency of equipment . . . provides longer service life.

For maximum convenience, use castables made with LUMNITE cement. These are packaged mixtures, ready for use. Just add water, mix and place. Made and distributed by leading manufacturers of refractories.

For more information, write: Universal Atlas, 100 Park Avenue, New York 17, N. Y.

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"LUMNITE" is the registered trademark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company

L-162

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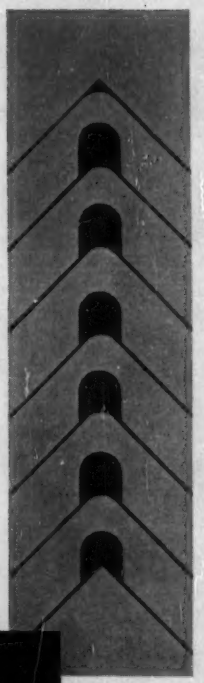

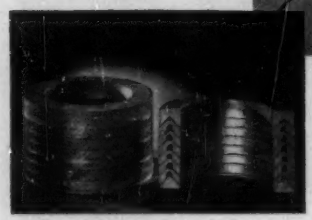

Garlock CHEVRON Packing
Set and cross section

CHEVRON®

is a registered trademark of The Garlock Packing Company. It is our responsibility as the manufacturer to see that this trademark is properly used at all times to identify our hinge-type packings. We, therefore, ask that it be used only to designate our product. It should never be used merely as a descriptive or generic term for V-type packings.

CHEVRON Packings are carefully manufactured in Garlock's own factories by experienced craftsmen. Therefore, whenever you see this familiar trademark you can be sure that the packings described will give you long dependable service because they are properly designed and manufactured to the highest quality standards.

Other familiar registered trademarks belonging to Garlock include: BITAN Leather Packings, GUARDIAN Gaskets, KLOZURE Oil Seals, LATTICE BRAID Packings and MECHANIPAK Mechanical Seals. All of these products are sold to you under the Garlock Warranty . . . your assurance that they will satisfactorily perform the service for which they are designed.

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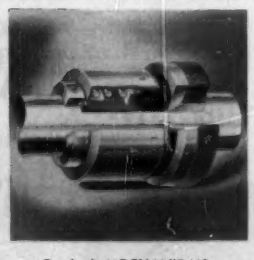
Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

Garlock BITAN Leather Cups, Packings and Gaskets



Garlock MECHANIPAK Mechanical Seal

Garlock GUARDIAN Spiral-Wound Gasket

Garlock KLOZURE Oil and Grease Seals for Bearings

Garlock LATTICE-BRAID Rod and Shaft Packings

How Standard "beefs up" cattle to help meet the West's growing food needs

New Standard plant foods have produced twice as much beef from a single acre—enough extra beef to supply an average person for a solid year.

Who eats the most meat in the U.S.? You do—surveys show Westerners top the nation in meat consumption. Now Standard helps ranchers satisfy that hearty appetite with chemically blended plant foods,* so economical they can be used to turn unproductive foothills into profitable pasture-land.

These new blends of essential plant-growth elements come from a $16 million Standard plant opened just a year ago. Grasslands they have enriched are now producing up to *twice as much* beef per acre. Farmers find them equally productive on many other crops. For you they promise tastier, more nutritious meals for every dollar you spend on food.

Progress in the West means...

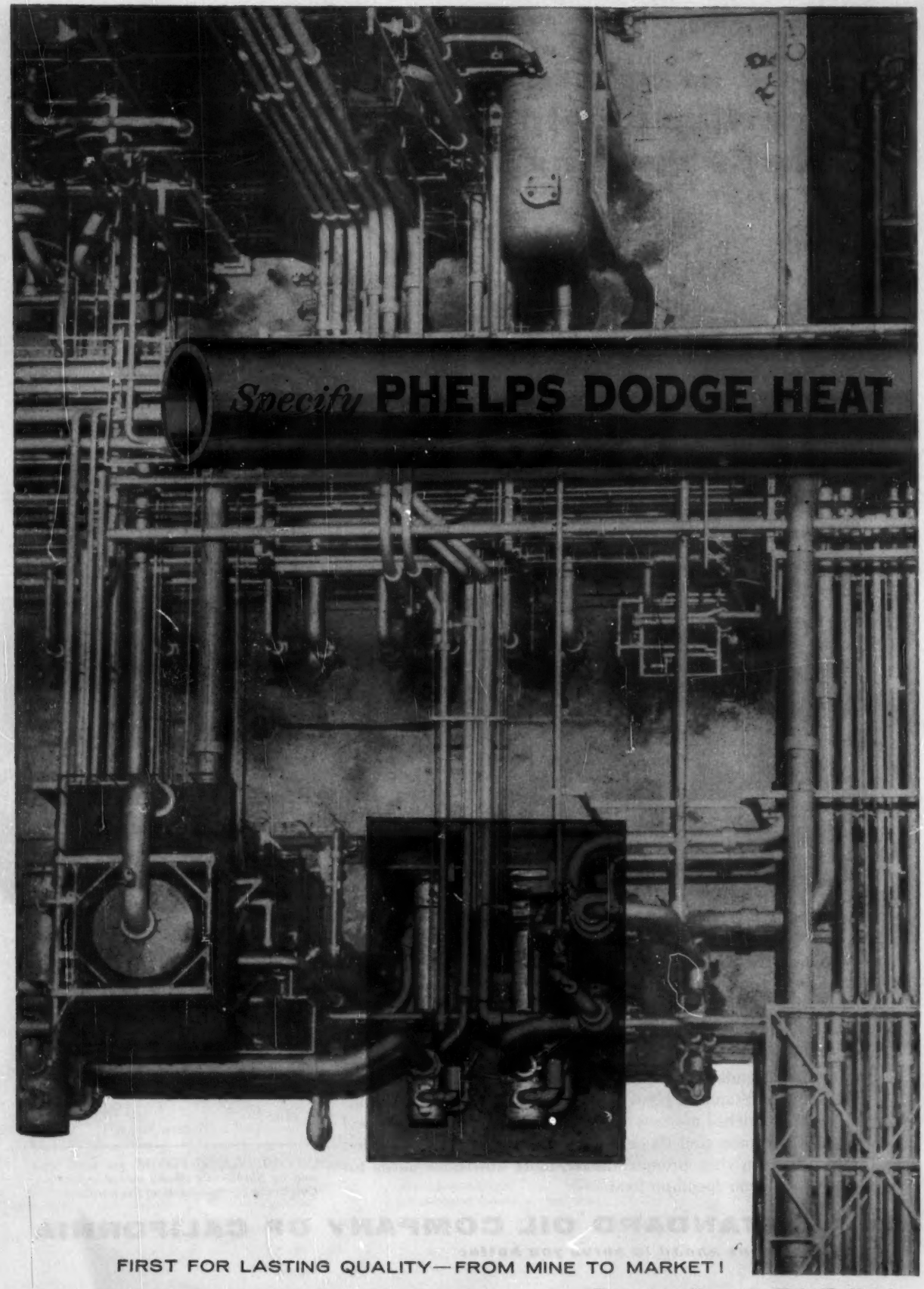
Producing 575,000 more tons of beef by 1967 to supply our† growing population

†7 Western States

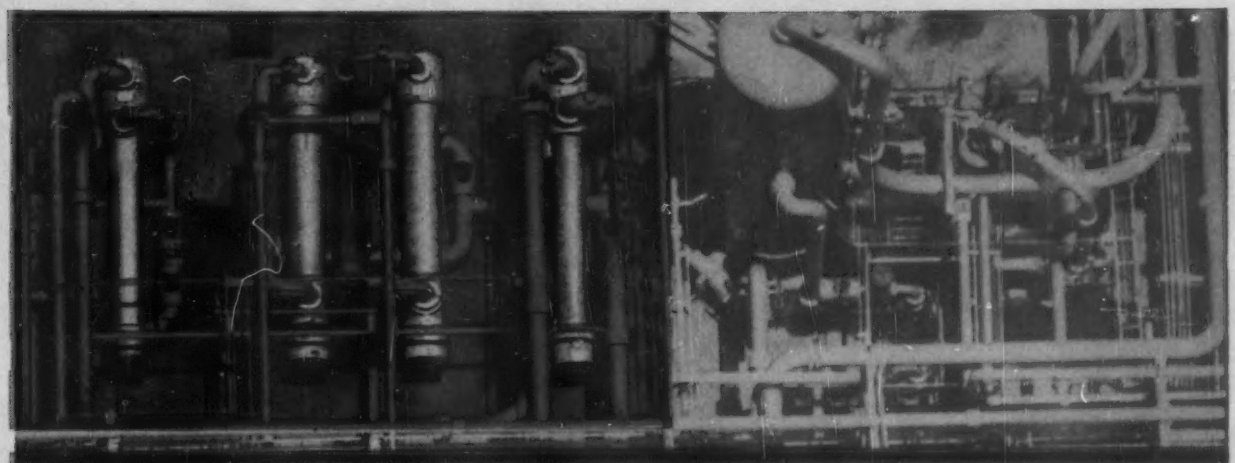
**ORTHO PLANT FOODS are made and sold by Standard's wholly owned subsidiary California Spray-Chemical Corporation.*

STANDARD OIL COMPANY OF CALIFORNIA

plans ahead to serve you better

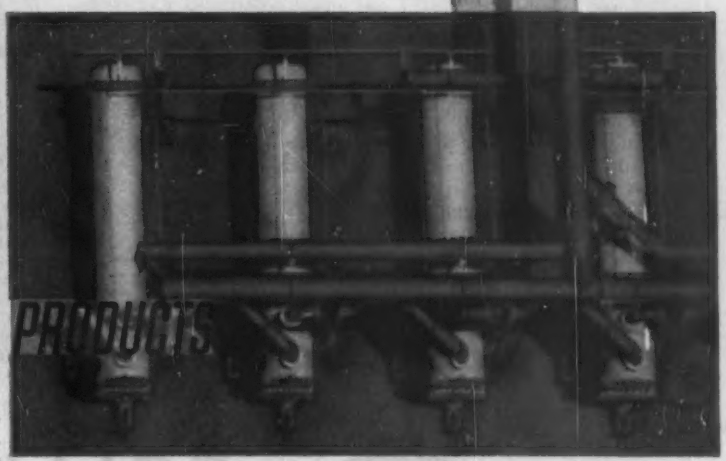


FIRST FOR LASTING QUALITY—FROM MINE TO MARKET!



EXCHANGER TUBES *for Longer Service!*

- Full range of copper-base alloys for every application.
- Vast background of application engineering to assist in proper alloy selection.
- Complete control of quality throughout every step of manufacture.



PHELPS DODGE COPPER PRODUCTS CORPORATION

PHELPS DODGE COPPER PRODUCTS CORPORATION

SALES OFFICES: Atlanta, Birmingham, Ala., Cambridge, Mass., Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Fort Wayne, Greensboro, N. C., Houston, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Washington, D. C.

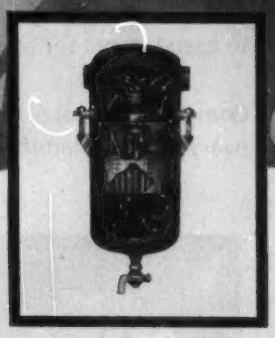
The secret of cruising in orbit
Was told to his canine by Corbett:
"When you're smacked in the face, by stardust in space
Let a Staynew Filter absorb it."

Sputnik, Muttnik, or Whatnik *we've* always known that Dollinger Filters are simply "Out of this World." That's what we've been trying to tell you these past months! But I suppose you've become immune to such claims and just haven't bothered to investigate.

Possibly there is a moral here (If you like morals):

Perhaps your biggest competitor did investigate, and right now a Dollinger Staynew Filter may be helping him make his product better than ever.

Seriously, shouldn't you investigate the design advantages of Dollinger Filters? It will cost you nothing and you may save yourself many headaches.



STAYNEW MODEL CPHS PIPE LINE FILTER

has the exclusive "double action principle." Air is first deflected to outer walls of Filters and forced downward at high speed. Water, oil, and heavier particles of rust, etc. are thus deposited in base. Mechanically cleaned air then rises to pass through filtering medium which removes lighter airborne particles. This "double action" design eliminates need for frequent cleaning.

Inexpensive, simple to install, Dollinger Pipe Line Filters pay for themselves in reduced maintenance alone. Why not talk over your filtration problems with a Dollinger engineer . . . or write for Bulletin 200 which gives engineering data on pipe line filters. Dollinger Corporation, 47 Centre Park, Rochester 3, N. Y.

PROTECTOMOTOR

STAYNEW **DOLLINGER**

FILTERS

LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS • ELECTROSTATIC FILTERS • MIST COLLECTORS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS • VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS HIGH PRESSURE FILTERS • AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS

For more data on advertised products, use Readers' Service Cards, last page.

Where service begins-LAYNE

A telephone call brings action—for the service facilities, know-how and experienced work crews of your nearby Layne Associate Company.

Layne service is based upon undivided responsibility throughout every phase of every water development job, from initial surveys and construction, to operation and maintenance.

For service before, during and after well construction, look to Layne and your nearby Layne Associate Company, a member of the community it serves.

Completely equipped work crews handle water well and pump servicing — backed by over 75 years of field experience.

LAYNE & BOWLER, INC. MEMPHIS
General Office and Factory — Memphis 8, Tenn.
Layne Associate Companies throughout the world.

Water Wells • Vertical Turbine Pumps • Water Treatment

LAYNE & BOWLER, INC.
Memphis 8, Tennessee

Gentlemen:

Please send me Bulletin No. 100

Name _____

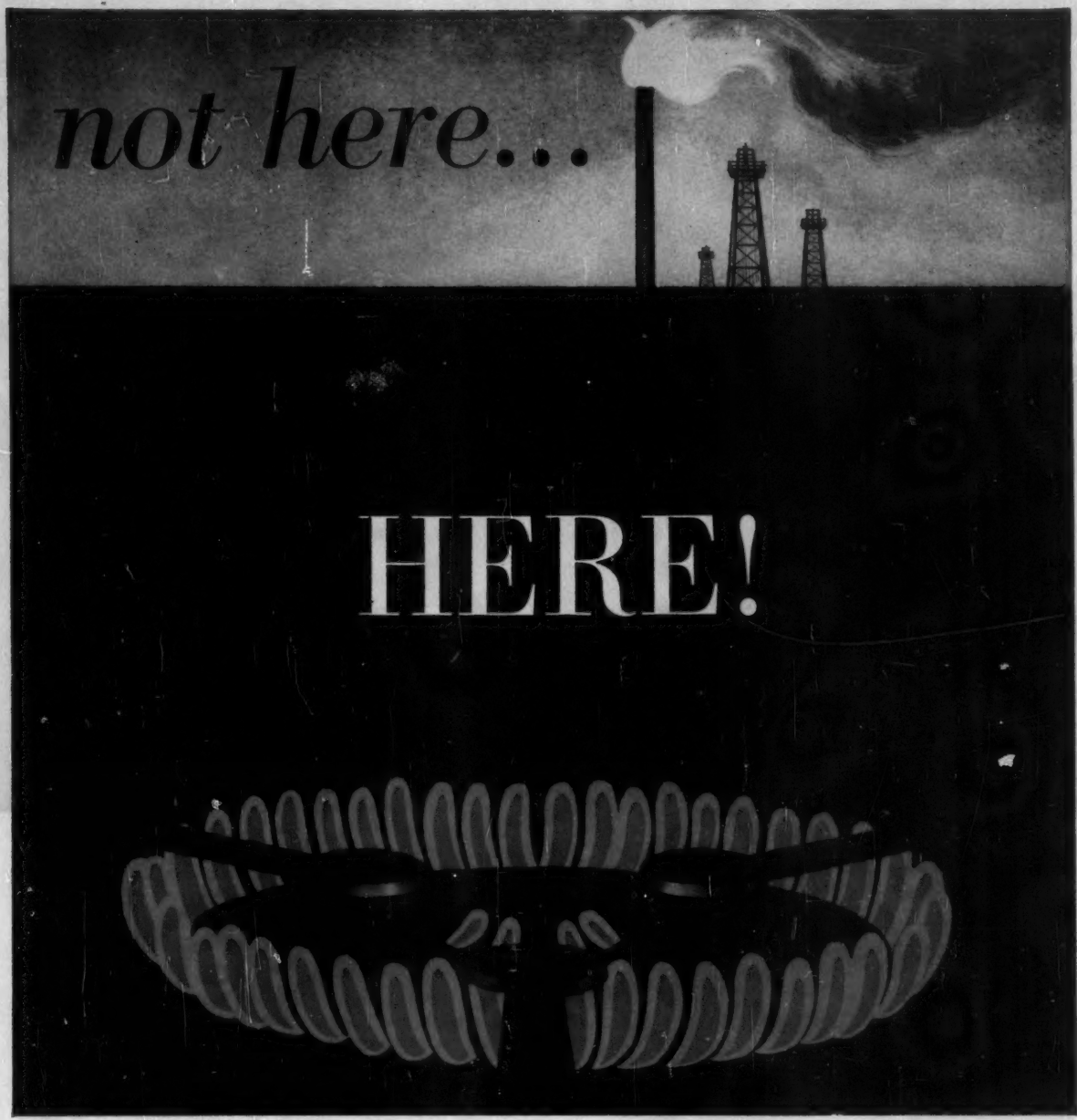
Title _____

Organization _____

_____

Address _____

City _____ *State* _____



because of GLYCOLS *and* ETHANOLAMINES

Wet or sour gases, once flared as a nuisance, now produce millions in revenue — thanks to the glycols and ethanolamines. If you use these versatile chemicals for gas dehydration or purification, you want to be sure of steady supply and instant service. Allied glycols and ethanolamines are available in tank car lots from Nitrogen Division's Orange, Texas plant, and in tank trucks or drums from warehouses in principal producing areas. Allied's technical specialists are always on call to help with any application problems you may have.

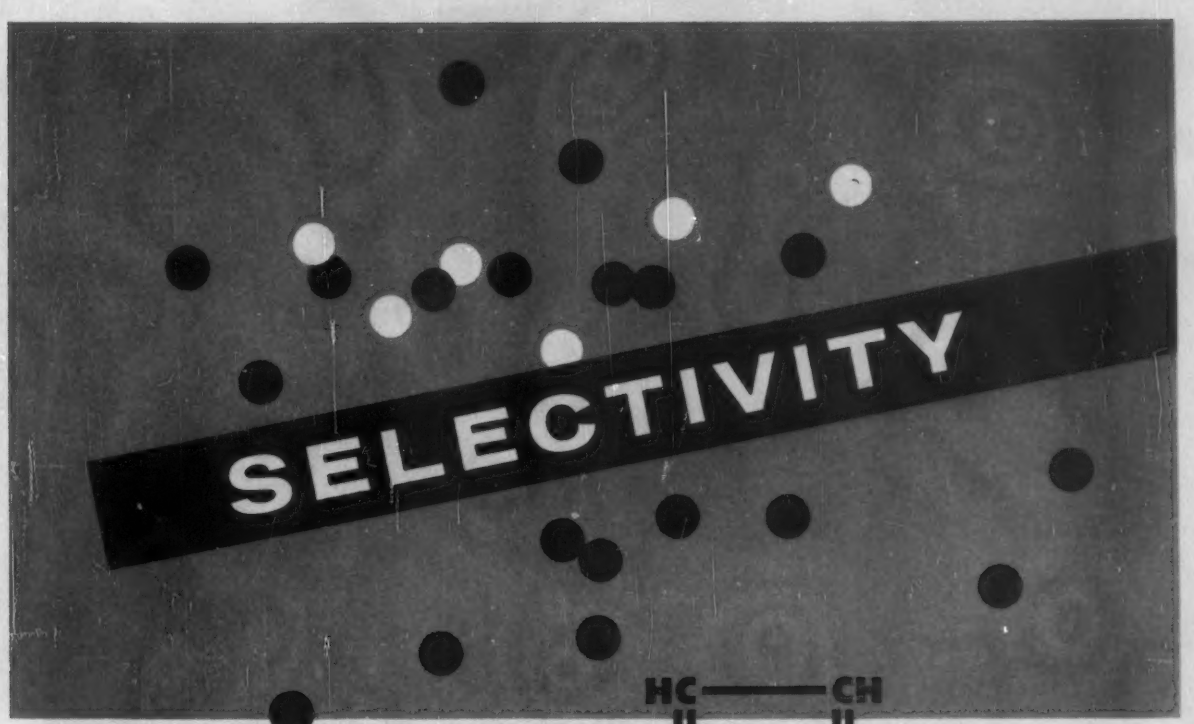
Dept. GA 1-21-6

Allied Chemical — Nitrogen Division

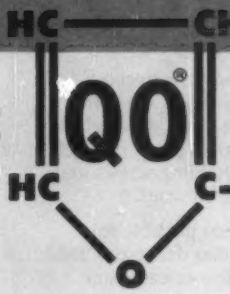
40 Rector Street, New York 6, N. Y.

Ethanolamines • Ethylene Oxide • Ethylene Glycols • Urea • Formaldehyde • U. F. Concentrate—85 • Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Sodium Nitrate • Methanol • Nitrogen Solutions • Nitrogen Tetroxide • Fertilizers & Feed Supplements

For more data on advertised products, use Readers' Service Cards, last page.



always a feature of QO® Furfural



Both structure and physical properties of furfural support its wide use as a selective solvent. This highly polar molecule favors sharp separations of saturates from unsaturates in lube oils, gas oils, cycle stocks, and other petroleum products. It is even effective in separation of organic sulfur compounds, or heavy metal complexes from petroleum fractions. The excellent selectivity is proven daily by the high yields of finished products from commercial installations throughout the world.

Add to this feature the fact that furfural is readily recovered from aqueous or non-aqueous solutions by flash vaporization, straight distillation, steam stripping, or water extraction at surprisingly low cost. The net result—use of furfural is paying off for many people, and it can do as much for you.

Solvent refining with versatile QO furfural is a process worth investigating. May we discuss the matter with you? Write The Quaker Oats Company, Chemicals Department.

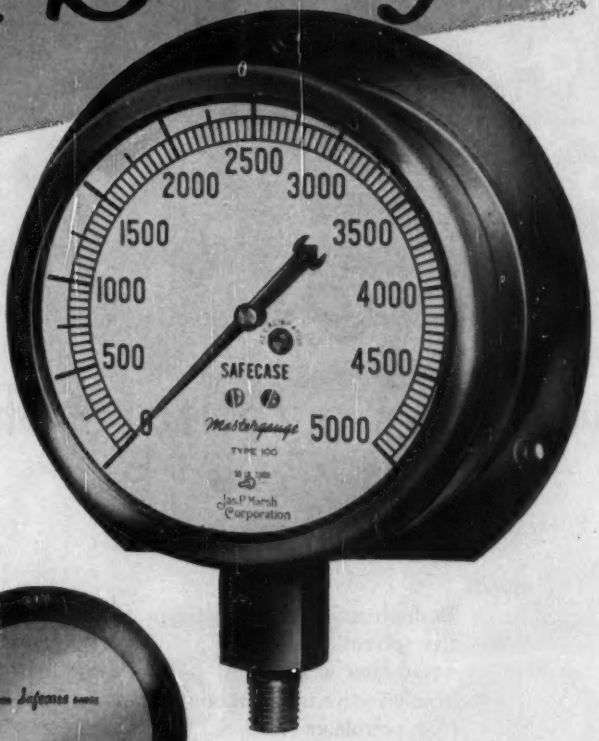
The Quaker Oats Company
CHEMICALS DEPARTMENT

Write for Bulletin 203-A, "Physical Data on QO Furfural"

340A The Merchandise Mart, **Chicago 54, Illinois.** Room 540A, 120 Wall Street, **New York 5, New York.** Room 440A, 48 S.E. Hawthorne Blvd., **Portland 14, Oregon. In the United Kingdom:** Imperial Chemical Industries, Ltd., Billingham, England. **In Europe:** Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands; Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France; A/S "Ota," Copenhagen, S. Denmark. **In Australia:** Swift & Company, Ltd., Sydney. **In Japan:** F. Kanematsu & Company, Ltd., Tokyo.

Now...a New advance in...

Gauge Safety!



Another step ahead in Marsh Gauges: the new Marsh "Safecase". Down to the final detail this gauge is developed for those applications where an unexpected surge of heavy, explosive over-pressure can occur.

In the "Safecase" a solid metal barrier protects the entire face. But, still more important, the *entire back* of the gauge is a thin, ductile plate, designed to open out when subjected to abnormal pressure. Back plate is held firmly to the case by two holding screws and cannot be dislodged by a pressure blowout.

In exhaustive tests it has never been possible to shatter the crystal or create any other dangerous condition in a "Safecase" gauge with its safety-release back. The accompanying illustration shows the result of one of a series of tests in which blank cartridges were fired in the back of the case without even breaking the crystal. Think what that means in safety to operating men!

Yes, an important development . . . but merely the kind you would expect from the manufacturer who originated the "Connoweld" tube, the "Marshalloy" case, the Mastergauge movement and practically all of the major advancements in pressure gauges. Ask for up-to-the-minute information.

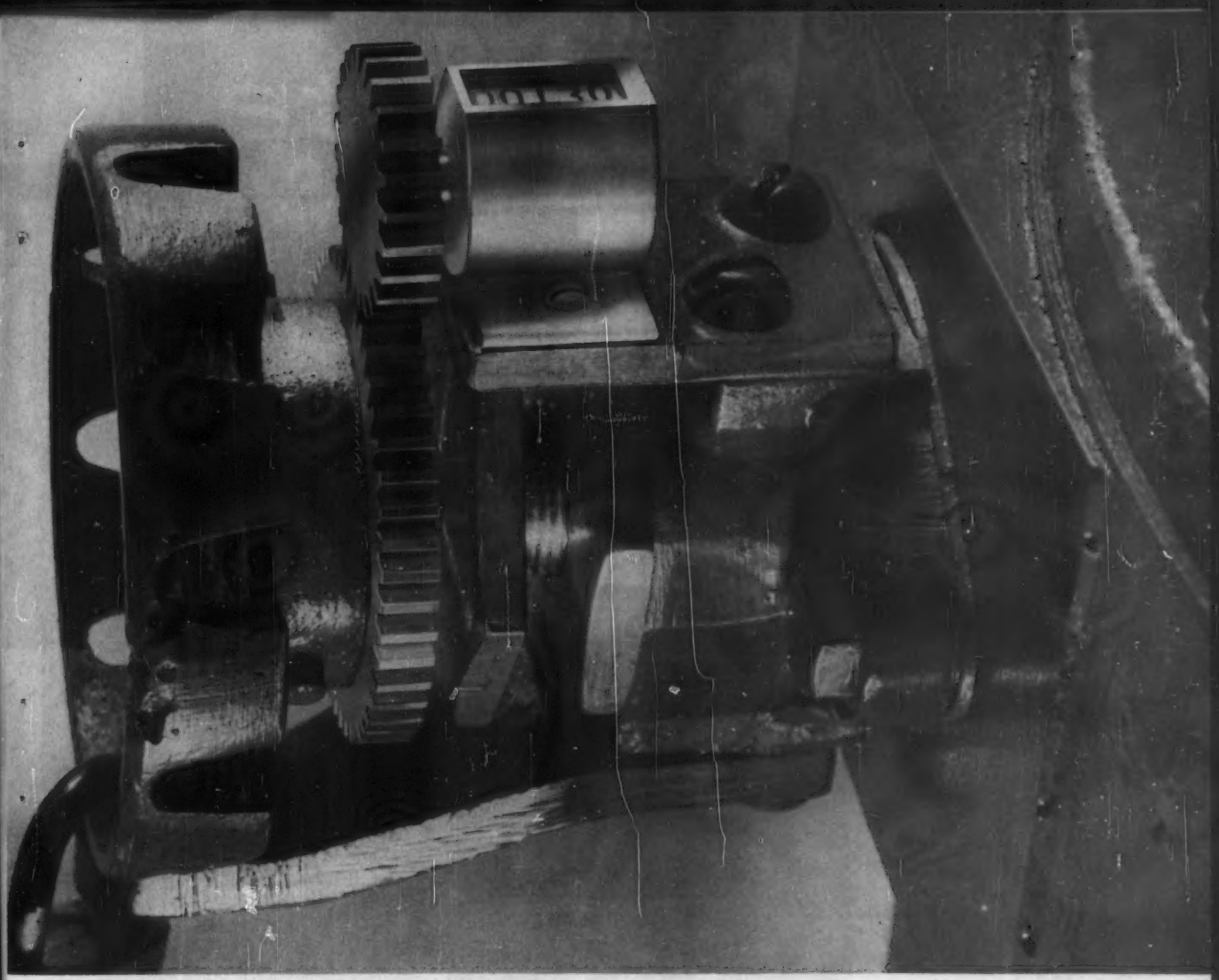
Pressure of explosive force merely opens out safety back

Instead of depending on blow-out plugs, entire back of Safecase Gauge is designed to yield to over-pressure. Photo at left shows actual result of firing cartridge within back of case. Safety-release back exhausted pressure. Front remained intact.

MARSH INSTRUMENT CO.
Sales affiliate of Jas. P. Marsh Corp.
Dept. R., Skokie, Illinois
HOUSTON BRANCH PLANT:
1121 Rothwell St., Sect. 15, Houston, Texas
Marsh Instrument & Valve Co. (Canada) Ltd.,
8407 103rd St., Edmonton, Alberta, Canada

"THE STANDARD OF ACCURACY"

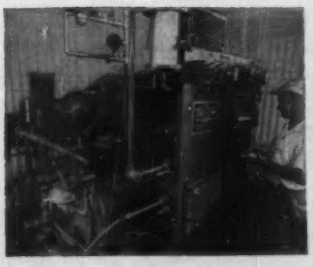
MARSH GAUGES



Air-Gas Ratio Valve

For precise control of inert gas quality . . .

Come to Kemp



This Kemp Model 3-MIHE Inert Gas Generator provides up to 3,000 cu. ft. per hr. at Quaker State's Farmer's Valley, Pa. plant. Like all Kemp units, it maintains a steady supply at even pressure, regardless of line demands!

Only Kemp Inert Gas Generators have the famous Kemp Industrial Carburetor at the vital heart of the process. This carburetor, developed and patented by Kemp, gives exacting control to the generation of inert gasses. From mere pilot burner operation to full generator capacity, inert gas analysis is exact and constant, regardless of demands on the system.

Kemp-produced inerts are low-cost inerts. You can use them liberally, at a fraction of the cost of bottled gasses, for purging, blanketing, controlling reactions, agitation, or any of a hundred applications. You get better quality control and increased safety at the lowest possible operational cost.

For round-the-clock inert production with minimum maintenance, depend on Kemp Inert Gas Generators. Your Kemp Representative will suggest the proper model to fill your needs. Or write us direct for Bulletin I-10. The C. M. Kemp Mfg. Co., 405 E. Oliver St., Baltimore 2, Md.

Kemp Convection Dryers

Kemp Immersion Melting Pots

KEMP OF BALTIMORE

Kemp Industrial Carburetors

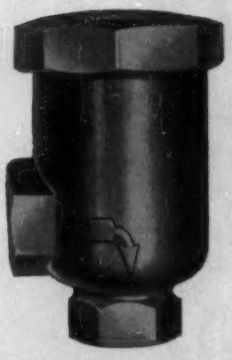
Kemp Oriad Dryers

need

steam traps?

name the way you want them!

TYPE A



TYPE D

TYPE C

Nicholson can supply your steam traps, exactly as you want them . . . for any service, any condition. Name the size, material, pressure, capacity you need. Types A, D, C are the ones you'll most likely use. Make your selection.

Sizes: A—from ¼" to 1". D—from ¼" to ¾". C—from ½" to 2".

Materials: Cast Iron and Cast Steel.

Pressures: A and D—Vacuum to 200 lbs. C—Vacuum to 300 lbs.

Capacities: From two to six times greater orifice area and capacity than other traps of comparable size.

Why wonder about your steam traps . . . when you can get Nicholsons exactly as you need them for your own applications. Nicholson traps are simple in design, have only one moving part . . . a valve that discharges condensate and prevents steam loss.

You get faster warmup, with high air-venting capacity. You eliminate costly leakage, with a powerful shut-tight valve action. You get a trap that's service-tested, when you specify Nicholson. You can try one . . . without obligation! W. H. Nicholson and Company, 12 Oregon St., Wilkes-Barre, Pa. Sales and engineering offices in 98 principal cities.

NICHOLSON

of Wilkes-Barre

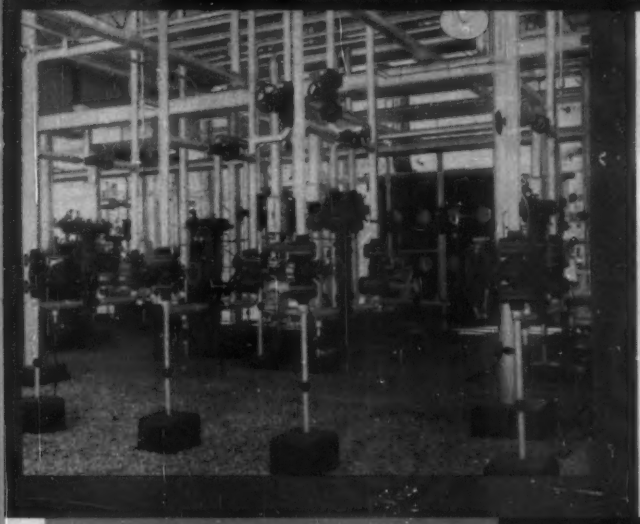
For more data on advertised products, use Readers' Service Cards, last page.

stop

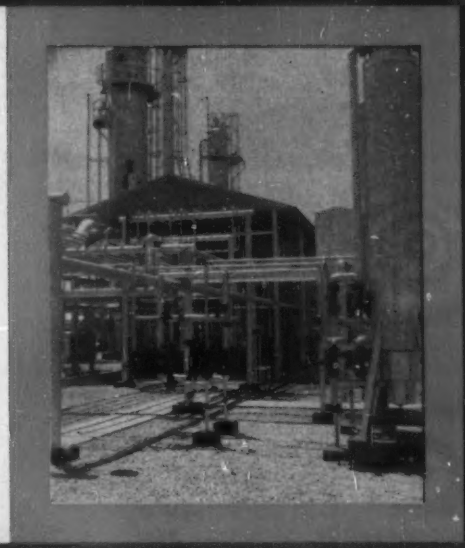
product contamination before it begins

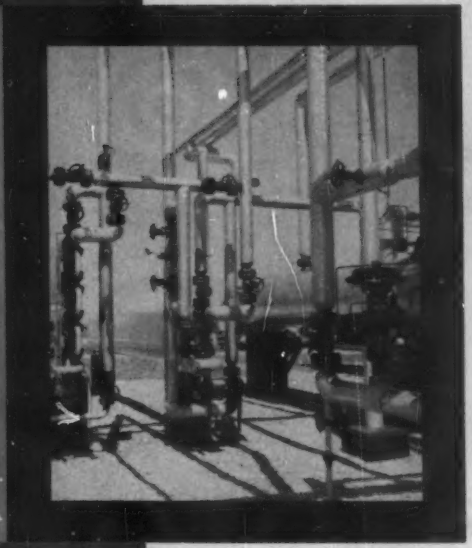
by using orbit forged steel asa class valves

because with orbit's non-lubricated positive closure seating principle ...costly re-runs are eliminated



LEFT
AT A KANSAS GASOLINE PLANT:
In foreground, depropanizer and debutanizer, reflux accumulator pressure relief and level control valves. Reflux pumps in background.

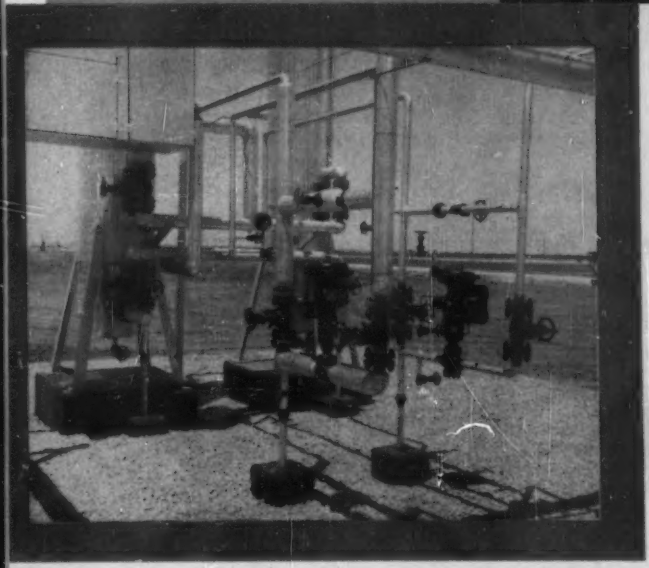




ABOVE
Left to right, de-ethanizer feed, bottoms exchanger, and liquid level control valve.

LEFT ABOVE
Propane dehydrators in right foreground. In background, plant process pump area.

LEFT
Propane dehydrators



ORBIT ASA CLASS VALVES are available in Carbon or Stainless Trim. Full Round Opening Sizes 1" thru 4". Ratings: 300 lbs. thru 2500 lbs. Flanged or Screw Ends. Venturi Opening Sizes 2" thru 6". Ratings: 150 lbs. thru 2500 lbs. Flanged End Only.

Available thru your favorite oil field supply store or refinery supply house.

ORBIT VALVES®

ORBIT VALVE COMPANY
BOX 699, LUther 4-4761, TWX TU 925 TULSA, OKLAHOMA

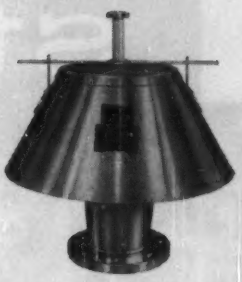
WAREHOUSES: HOUSTON, TEXAS, 407 Velasco, CApitol 8-6623, TWX HO 115; ODESSA, TEXAS, 402 West County Road, FEderal 7-2263, TWX ODESSA TEX 8041; EDMONTON, ALBERTA, CANADA, 7119-104th Street, Phone 391-283

WEST COAST REPRESENTATIVE: Fred P. Koenig Company, Long Beach, Calif., 3815 Atlantic Avenue, GArfield 4-3834

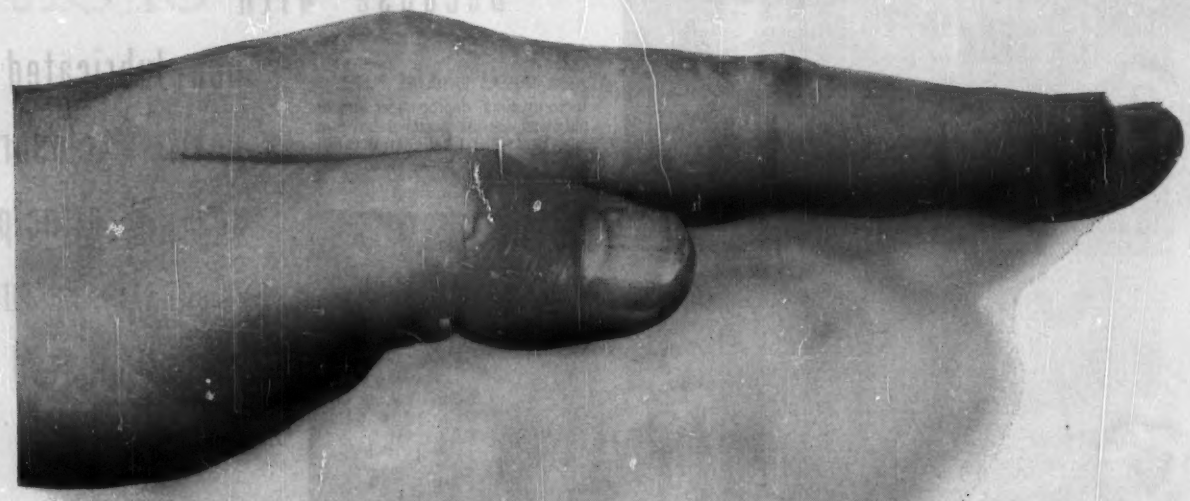
CANADIAN REPRESENTATIVE: T. R. Pickford & Company, Ltd., Calgary, Alberta, 536 8th Avenue West, Phone 2-7371

EXPORT REPRESENTATIVE: New York 36, N. Y., 500 Fifth Avenue, BRyant 9-2236

new **S&J** *Breather Valves*



Materially Reduce Storage Tank Vapor Loss



New Shand and Jurs model ST-9749 diaphragm-type breather valves are a major achievement in storage tank venting and vapor conservation. They provide resistance to sticking, corrosion and freezing never before offered. In addition they require practically no maintenance feature non-wetting teflon-on-fiberglas diaphragms for maximum performance and longer life; completely eliminate critical drain holes or other areas that require continuous checking. Ruggedly built from aluminum and stainless steel, ST-9749 breather valves are lightweight, and already available in 4″, 6″, 8″, and 10″ sizes. Call your nearest S&J branch office or sales representative for Technical Bulletin 52D-ST-9749 Breather Valve.

SHAND AND JURS

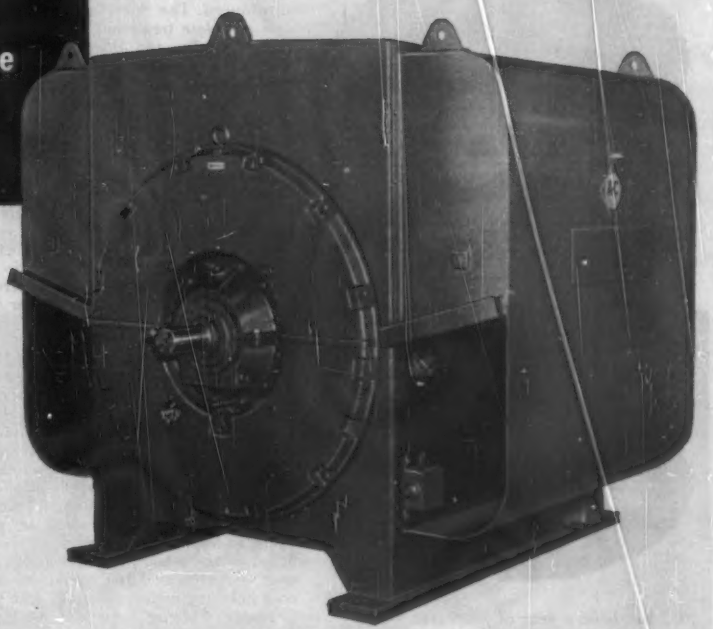
GENERAL PRECISION EQUIPMENT CORPORATION GPE

2600 Eighth Street, Berkeley, California
Branch offices and representatives in principal cities

For more data on advertised products, use Readers' Service Cards, last page.

Eliminate costly enclosures with Allis-Chalmers weather-protected MOTORS

Modern features
cut operating, maintenance expense . . . give MORE dependability



Here's a newly designed line of Allis-Chalmers weather-protected motors with the ability to "take" outdoor conditions. This means no expensive protective enclosures are needed . . . a big saving in plant or installation building costs.

Designed to meet defined NEMA requirements, these motors incorporate many important features which assure dependable outdoor operation:

- **Ventilating System** — Low velocity intake, vertical lift, change of direction and high velocity discharge of ventilating air keep rain, snow, sleet, dust and dirt out of vital parts.
- **Removable Air Ducts** — To facilitate inspection and maintenance of interior air passages, air intake ducts are designed for quick removal.
- **Stator Assembly** — Removable as a unit, it simplifies maintenance and minimizes downtime.

Silco-Flex is an Allis-Chalmers trademark.

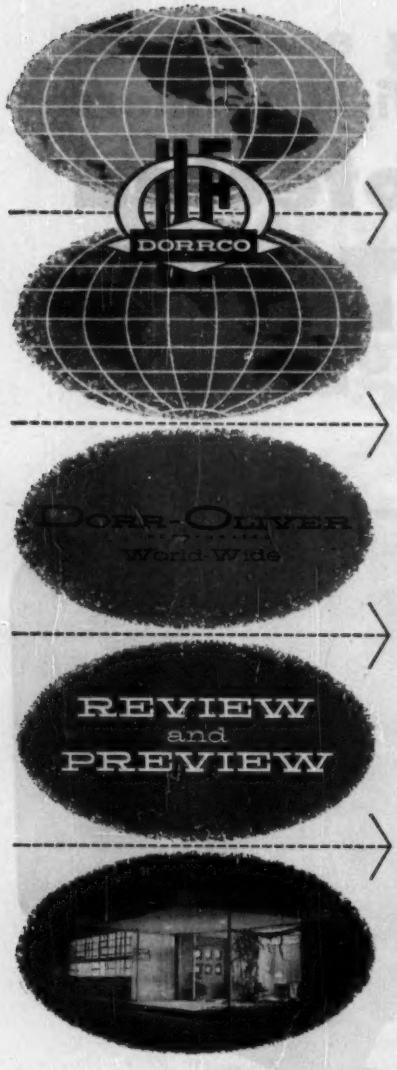
- **Split Sleeve Bearings** — Capsulized design permits access to motor interior without disturbing the bearings or their enclosures. Positive vapor seal is used on high-speed motors. Antifriction bearings are available for slow speed motors.
- **Proven Insulation** — Famous Allis-Chalmers insulation systems (Class A and B) are available. And, for extreme temperatures, or where high resistancé to abrasion and moisture is required, Allis-Chalmers can provide the revolutionary *Silco-Flex* system.

THIS DESIGN available in ratings from 250 to 900 hp. Other designs in larger horsepower ratings are also available. Contact your A-C sales office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin. Ask for Bulletins 51B8606A and 05B7894.

A-5292

ALLIS-CHALMERS

NATIONAL ELECTRICAL WEEK
FEB. 9-15, 1958



1957 has been a year of contrasts.

Significant advances in technology, the completion of a substantial portion of our program to expand our productive capacity in the U. S. and Canada and the strengthening of our marketing organization are all tangible achievements which will bring us both immediate and long-term benefits. On the other hand, a generally lower activity in new projects coming in has emphasized the narrowing profit margins faced by most businesses and points up our insistence on improving designs, reducing costs and increasing efficiencies.

Abroad, the picture is bright. Our subsidiaries report current high levels of business and there is great optimism for the future. Of particular interest is the success of our newest family member, Dorr-Oliver Pty. Ltd. of Australia, which opened its doors on January 1 of this year and by mid-year had far surpassed expectations. Growth of Dorr-Oliver (India) Ltd., another of our newer associates, has also been noteworthy, with the recent addition of local manufacturing facilities justifying still greater optimism.

SUGAR — In 1957 a total of 42 RapiDorr Clarifiers and 48 Oliver-Campbell Cane Mud Filters were sold to the cane sugar industry. A significant aspect of this outstanding record has been the increasing participation of our subsidiaries and representatives abroad. They are locally manufacturing, in some instances for the first time, 31 of these machines in Argentina, Brazil, England, France, Germany, India, the Philippines and South Africa.

POLYETHYLENE — The first Merco Pressure Centrifuges went into operation early last year removing catalyst from liquid polyethylene at capacities considerably in excess of original expectations. Overseas, British, Italian and German producers ordered Pressure Centrifuges for similar application in both new commercial scale and pilot plants.

SANITATION — One of the highlights of the year was D-O activity in the waste water disposal field. Four major new developments — all ideally suited for smaller plants — were introduced. The SpiroVortex System which is a complete treatment process akin to activated sludge, the Degritting Clarifier and Clarigester and the DorrClone Classifier as applied to sewage degritting have already been commercially proven at plants in the western U. S. First installations of the CompleTreator, a package plant to serve a population of 150, are now operating with some 30 additional units scheduled to start up in 1958.

Our subsidiary in the Netherlands has marketed equipment for facilities as far distant as Norway, Iraq and India, while new or enlarged D-O equipped domestic installations sold in 1957 can be found from New York City to Los Angeles and San Antonio, Texas to Fairmont, Minnesota.

GENERAL METALLURGICAL — Applications of the DSM Screen, first introduced in 1956, continued to grow in virtually every field we serve. One of the most promising has been magnetite recovery in heavy media cyclone plants on the Mesabi Range. Also new is the swing-type agitator for the American Filter — a development particularly applicable to filtration of heavy metallurgical slurries.

Following the trend noted in previous years, widespread acceptance of the Slurry Mixer by the cement industry and the Thickener — American Filter combination by the coal industry continued again last year. In Germany, France, India and Australia flue dust clarification and recovery contributed materially to our business and in Canada a substantial volume of Dorr-Oliver-Long shaft equipment and mine cars was purchased for underground mines.

PLANT ENGINEERING—At the year's end, design of a granular fertilizer plant for India and sections of a new Cuban nickel recovery plant were partially completed, and construction of three D-O designed phosphoric acid or fertilizer plants was progressing in Venezuela, England and Montana. During the year a 200,000 ton per year triple superphosphate plant in Florida and a Norwegian phosphoric acid installation were put into operation and brought up to design capacity in near record time.

FLUOSOLIDS SYSTEMS — Also in the fertilizer industry two western producers ordered the first FluoSolids Systems to be used for calcination of phosphate rock. Designed to handle a total of 1,500 tons per day, these installations were the direct result of successful field tests using a portable fluidized bed pilot plant. During the year other FluoSolids Systems were ordered to dry limestone and blast furnace slag in the U. S., roast copper matte in Belgium, calcine clay in Scotland, decompose copperas in England, and roast pyrite for a Japanese paper mill and an Italian sulfuric acid manufacturer.

The largest FluoSolids System for fine coal drying, handling over 600 tons per hour, went into operation during the third quarter at a new eastern preparation plant, and construction is nearing completion on a second similar, but smaller, installation. In the realm of unusual applications is a unit drying a highly-corrosive chlorinated hydrate at an eastern chemical plant.

WATER TREATMENT — In the southwestern United States the DorrClone Classifier has been used with notable success for the desanding of municipal well water supplies. For small plants the PeriFilter System with a single pre-treatment unit and split filter provides economical unitized water treatment.

Major expansions of the Louisville, Kentucky and Fort Worth, Texas treatment facilities will be D-O equipped as will new municipal plants at Springfield, Ohio; Peoria, Illinois; and Delhi, India. New industrial treatment installations will serve pulp mills in South Carolina, India and Venezuela and an Indian fertilizer plant.

PETROLEUM — Another modification of the familiar DorrClone Classifier is the Clay-Jector, latest development for control of drill mud weights. Noteworthy economies are possible using this unit which mechanically rejects undesirable drilled solids while recovering valuable barites for reuse.

CHEMICAL — A substantial amount of D-O equipment of all types has been incorporated into the unique flowsheet of a new astrakanite recovery plant in the Chilean nitrate fields. In Germany and the United States, Horizontal Filters have been widely applied to dewatering and washing of fine organics as well as highly corrosive inorganics, and around the world filters of both standard and special construction were ordered for an almost endless variety of services.

COPPER AND URANIUM—Last year substantial amounts of D-O processing equipment were purchased for new and enlarged copper mills in South America, Mexico, the Belgian Congo and United States and new uranium mills in Australia, United States and Canada. A new and improved design and method of fabrication of stainless steel rake Classifier blades was developed. Although conceived initially for the uranium industry this design is broadly applicable to classifications involving corrosive solutions. Certainly no summary of 1957 accomplishments would be complete without mention of the Chemical Engineering Achievement Award presented last month to a group of companies including Dorr-Oliver for their contribution to extractive metallurgy of atomic age metals. Interestingly enough, D-O was one of the very few engineering equipment organizations selected for the award.

With several years of expansion and enormous activity behind us, the current business plateau provides a much needed opportunity to consolidate and catch our breath. The real challenge will be to increase the spread between income and outgo through more efficient operation — while accelerating the rate of our technological advances. I am confident we can, and will, do both.

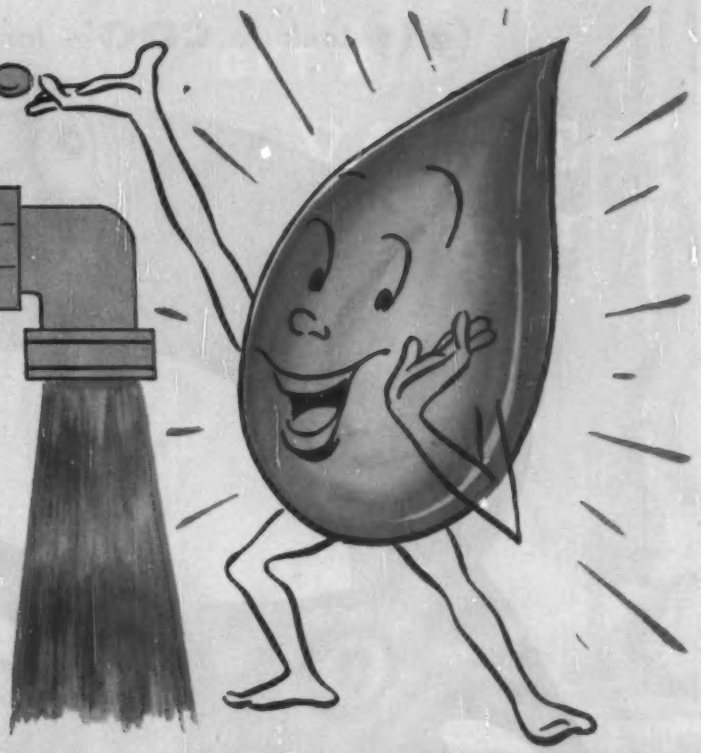
J. D. Hitch, Jr.
President

November 18, 1957

DorrClone, FluoSolids, PeriFilter and RapiDorr T.M. Reg. U. S. Pat. Off.

(Adv.)

ALLIS-CHALMERS
Water Conditioning



Announcing New Industrial Zeolite Water Softener

Basic standard water softener designs easily adapted to meet individual plant requirements.

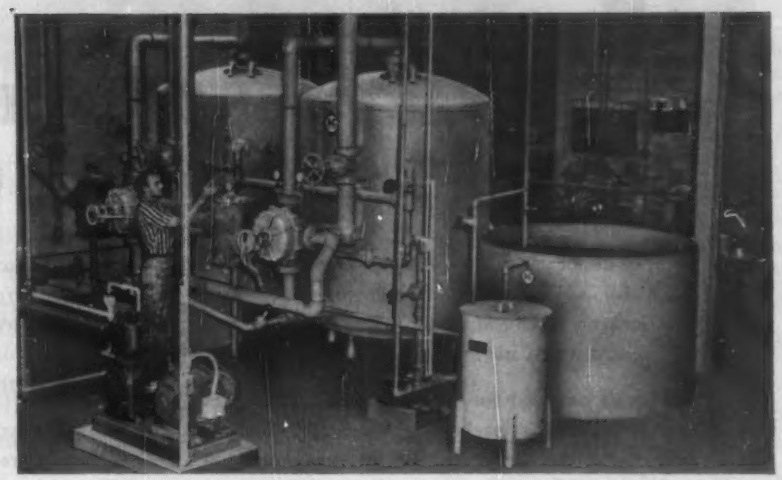
Here's a well-engineered, well-built answer to a wide range of water conditioning problems. It's designed to eliminate costly maintenance due to scaling of pipes and heat exchange tubes; to produce chemically suitable water for drying, paper making, textiles; and to provide water for food processing and many special industrial applications.

Easy Operation

The unit is basically simple. It is engineered to operate with little or no maintenance between regenerating cycles. Regeneration is an easy procedure. Automatic controls are also available to further simplify the operation if desired.

Standard Basic Design

Allis-Chalmers engineers started with a basic standard design developed from years of research and experience.



Allis-Chalmers sodium zeolite water softener installed in Ohio dye plant.

From this, a water softener is engineered to meet your individual plant requirements. Such factors as size of softener tank, size of salt and brine tank can be varied to meet your conditions.

Get Details

For complete details about Allis-Chalmers industrial type zeolite water softeners, call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS A-C ALLIS-CHALMERS

A-5552

Look to **COOK** for Better Packings!

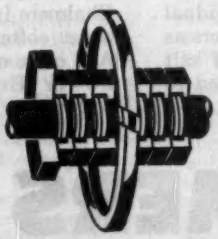
Don't Let This Happen To Your Packing Glands!

NO doubt about it — using the wrong material for a packing gland in corrosive service is like locking a wildcat in a cardboard box. It will be chewed up in no time!

There's no need for rust and corrosion to raise havoc with your packing glands, regardless of how tough the service. In 999 cases out of 1000, packing glands made of Cook stainless steel or Cook *Ni-Resist* type iron will solve your problem, once and for all.

For the remaining 1 problem in 1000, Cook can probably *design* an answer. That's because C. Lee Cook pioneered in the field of metallic packings — knows more about their specific, on-the-job applications than anyone else.

Whether you manufacture original equipment or want to recondition old packing cases, always insist on genuine C. Lee Cook parts and service. Write for full details. C. Lee Cook Company, 950 South 8th Street, Louisville 3, Kentucky.



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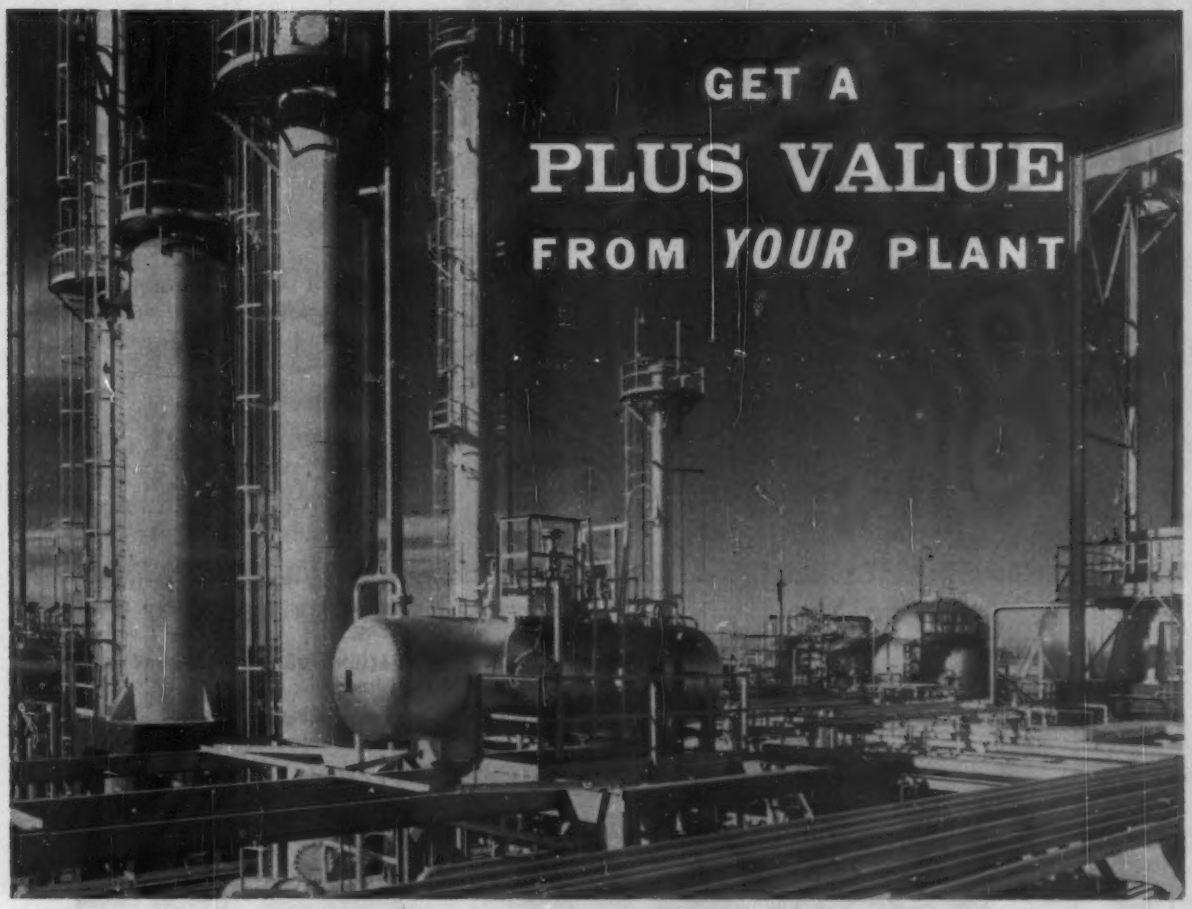

You always get a *plus value* in engineering ability and construction skill when your plant is planned and built by The REFINERY ENGINEERING Company. TRECO has never been guided by *minimum* requirements on any job, large or small.

Remember the *plus value* TRECO offers when you plan your next plant.

A brochure showing work done by TRECO is available. A copy will be mailed you promptly upon request on your company's letterhead.

TRECO

A DIVISION of VITRO CORPORATION of AMERICA

The REFINERY ENGINEERING Company

NEW YORK . TULSA TORONTO

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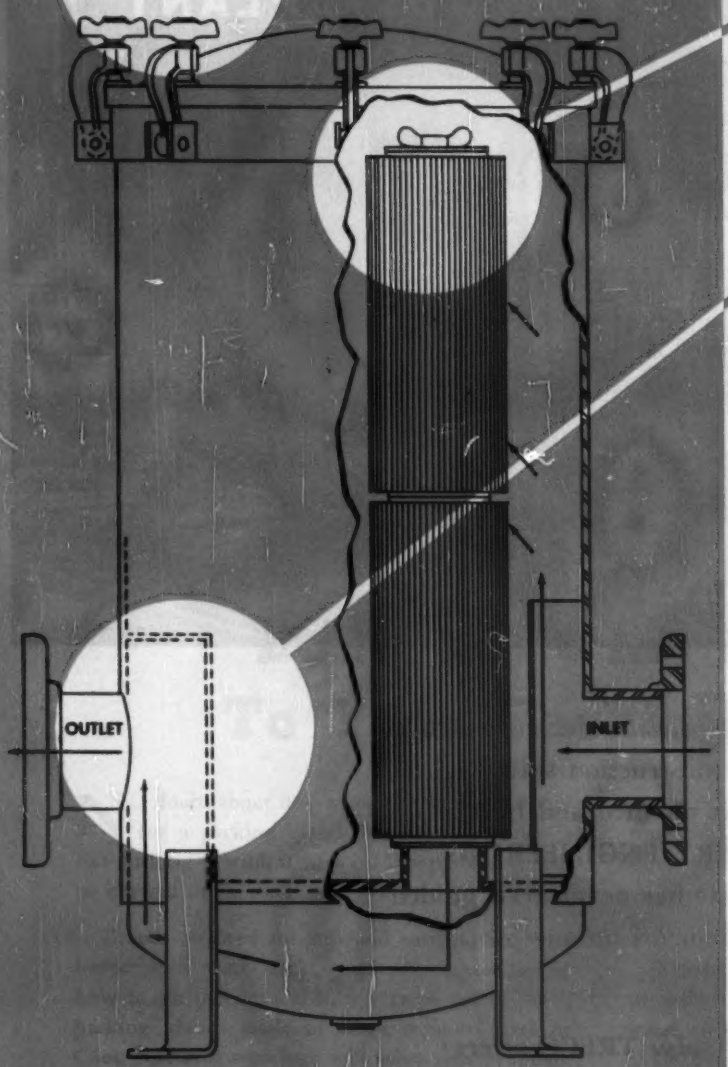

Easy Servicing

Just a twist of the wrist and the top swings open. No special tools needed; eliminates nuts and bolts; no busted knuckles.

Best Performance

PETROLEUM MARKETING FACILITIES: truck loading racks, aircraft fueling, fuel oil bulk plants.

MACHINE TOOLS: coolants and cutting oils, hydraulic oils.

INDUSTRIAL PLANTS: solvents, oils, water and other non-corrosive fluids.

WITH THE

New Excel-So

57 SERIES FILTERS

Check these advantages • Simplified construction—low initial cost • Reduced size for compact installation • Quick opening cover and provision for instantaneous cartridge change • Improved filtration efficiency and greater dirt holding capacity . . . result . . . low cost maintenance • Very low initial pressure drop • Available for vertical or horizontal installation • Location of inlet and outlet connections to customer specifications • Wide range of product applications • Units in standard design or for code requirements • Non-ferrous construction available • Extra accessories including air eliminator, pressure gage, dump valve, etc., available.

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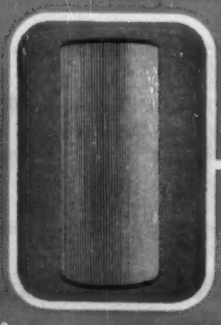


CH-57PL PLEATED CARTRIDGE

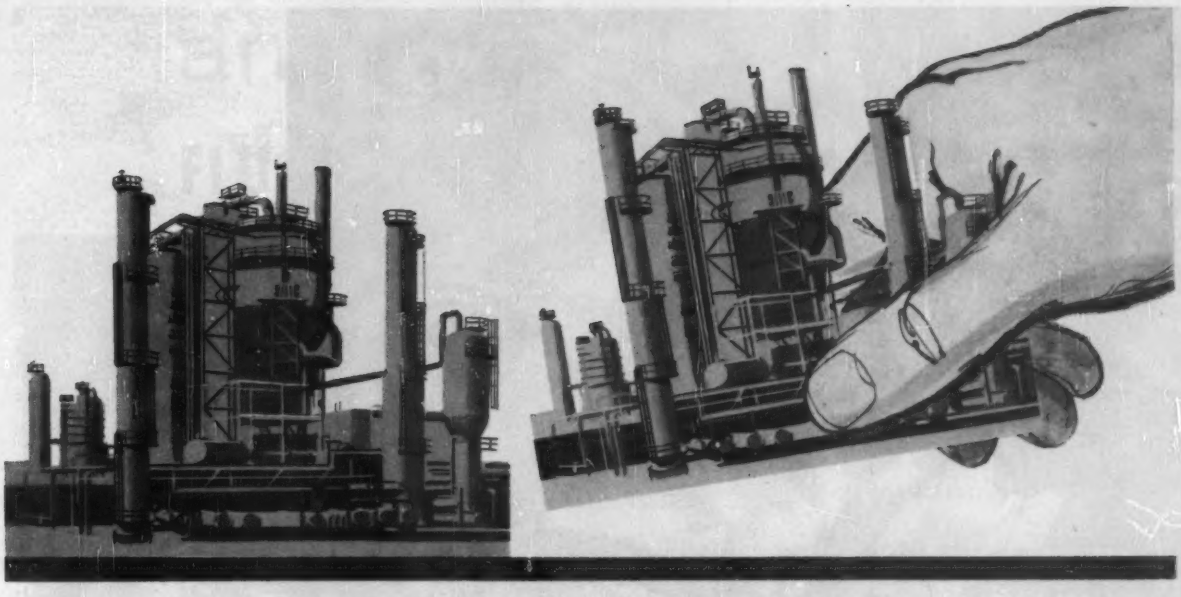
THE NEWLY Developed CH-57PL Cartridge combines

- Larger Outside Diameter
- Larger Inside Diameter
- Greater Height

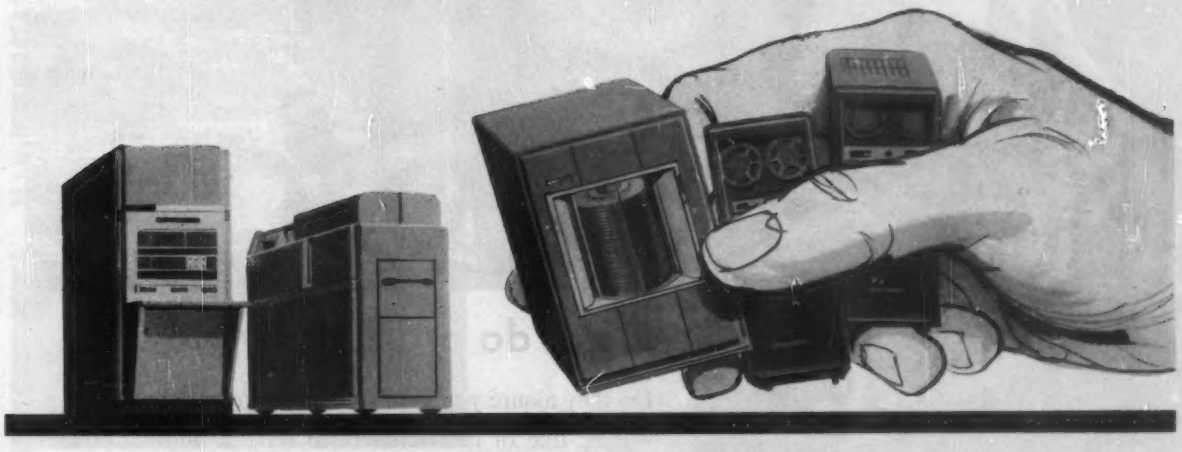
RESULT

- More Filtration Surface
- Lower Operating Cost
- Higher Flow Rates

Write for bulletin WL-6-56



TO KEEP PACE WITH YOUR GROWTH



THE **IBM 650** "BUILDING BLOCK" PLAN

With the IBM 650 you gain the *extra* advantage of an electronic system designed on flexible "building block" lines. A compact, self-contained processing unit, your basic IBM 650 can be added to as your refinery engineering and accounting needs grow—using magnetic tape units, RAMAC* disk memory and other optional features.

Prepare for expansion now with a versatile IBM 650 that can grow with you—and help you retain *tight management control* in the face of increasingly complex management, engineering and accounting problems.

Get this "building block" story from your local IBM representative or write: PETROLEUM DEPARTMENT A-58-a, International Business Machines Corporation, 590 Madison Ave., New York 22, N. Y.

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What do oracles say to you?

Do they assure you that your next critical piping job will be free of headaches from start to finish? You can make it so, if you deal directly with experienced specialists. In the interest of complete satisfaction, sound economy and permanent safety . . . ask us in.

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MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS

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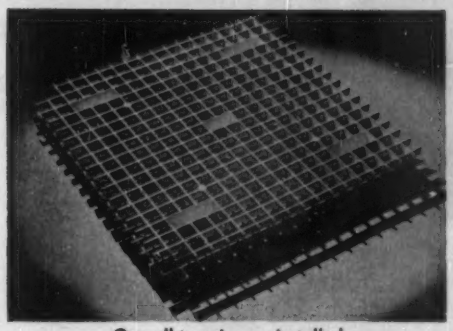
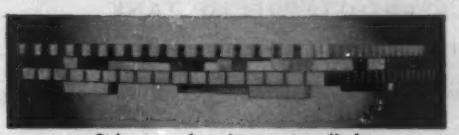
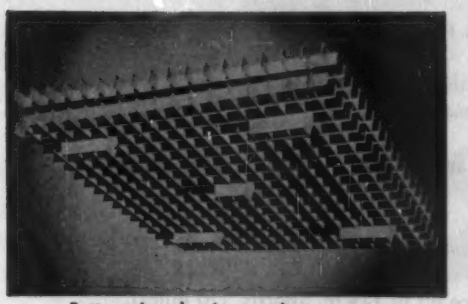
FLUOR'S NEW *poly-*GRID



Overall top view as installed



Side view of packing as installed



Bottom view showing spacing supports

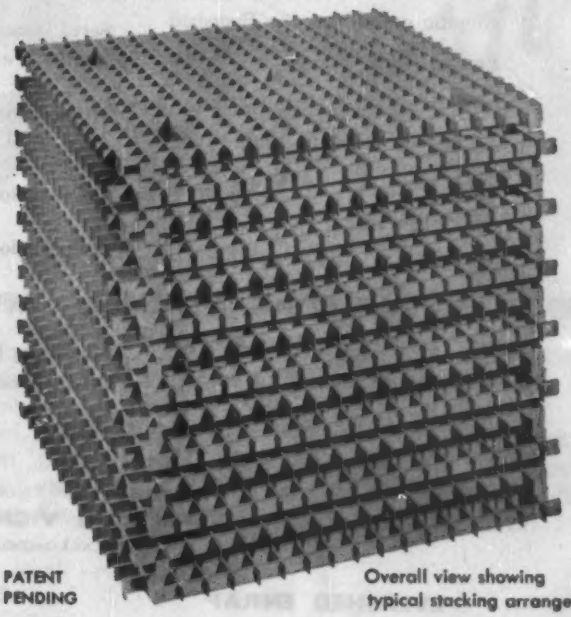
MORE COOLING IN YOUR EXISTING TOWER . . .

To increase the throughput of your existing counterflow induced draft cooling tower, Fluor Products Company now offers "Poly-Grid" packing.

This revolutionary packing provides greater cooling surface — greater overall heat transfer; yet construction is open, and pressure drop low.

"Poly-Grid" is available in high impact polystyrene or linear-polyethylene to meet all water conditions.

Fluor "Poly-Grid" packing allows you to cool more water under existing operating conditions, or to realize extra cooling of present throughput — all at minimum capital expenditure.



PATENT PENDING

Overall view showing typical stacking arrangement

Contact your nearest Fluor Representative for details.

POLY-GRID can be easily installed in any counterflow induced draft cooling tower—regardless of make or model!

Call him today!

FLUOR PRODUCTS COMPANY

A DIVISION OF THE FLUOR CORPORATION, LTD.

fp GENERAL OFFICES • WHITTIER, CALIFORNIA

EVERSHED PRECISE

TANK GAUGE

The most precise tank gauge of its kind in the world

At Oilfields and Refineries throughout the world the EVERSHED PRECISE TANK GAUGE is replacing manual dipping. Data essential to the day-to-day operation of Refineries is placed immediately, automatically and precisely at the disposal of oilmen.

Designed to withstand arduous climatic conditions the Evershed Precise Tank Gauge will work continuously with a minimum of maintenance and its accuracy will never vary.

Once the Precise Tank Gauge is installed to either a fixed or floating roofed tank many of your tank gauging problems may be forgotten.

A FEW TECHNICAL FACTS:

Servo systems on which the Precise Tank Gauge is based overcome any adverse effects of friction.

Measurement, top and interface level accuracy within 2.5 mm. (0.1").

Transmission, Evershed Powerotor system.

Transmission distance up to 17Km. approx. (10 miles).

Power supply 65 volts (Transformer supplied).

Flame and Explosion-proof;
Buxton's certificate, Group 2 gases.

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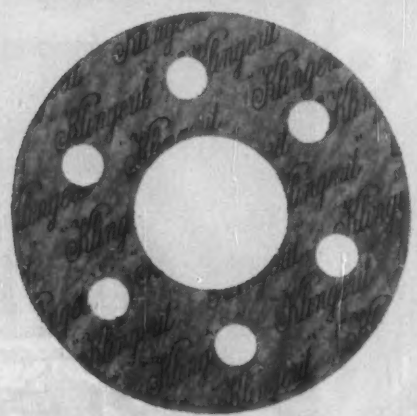

Klingerit

solves your jointing problem

The original compressed asbestos jointing, Klingerit was first manufactured over seventy years ago, and is used today in ships, refineries, chemical and power plants all over the world.

Specially suitable for HIGH PRESSURE, HIGH TEMPERATURE problems, it resists the action of steam, hot and cold water, hot and cold oils, petrol, benzine, the by-products of the coal industry, most acids, and chemicals in general. It will not burn, disintegrate or squeeze out. Thicknesses from .008″ to $\frac{1}{4}$″. Sheet sizes to 60″ x 160″.

Available from distributors in all principal cities.

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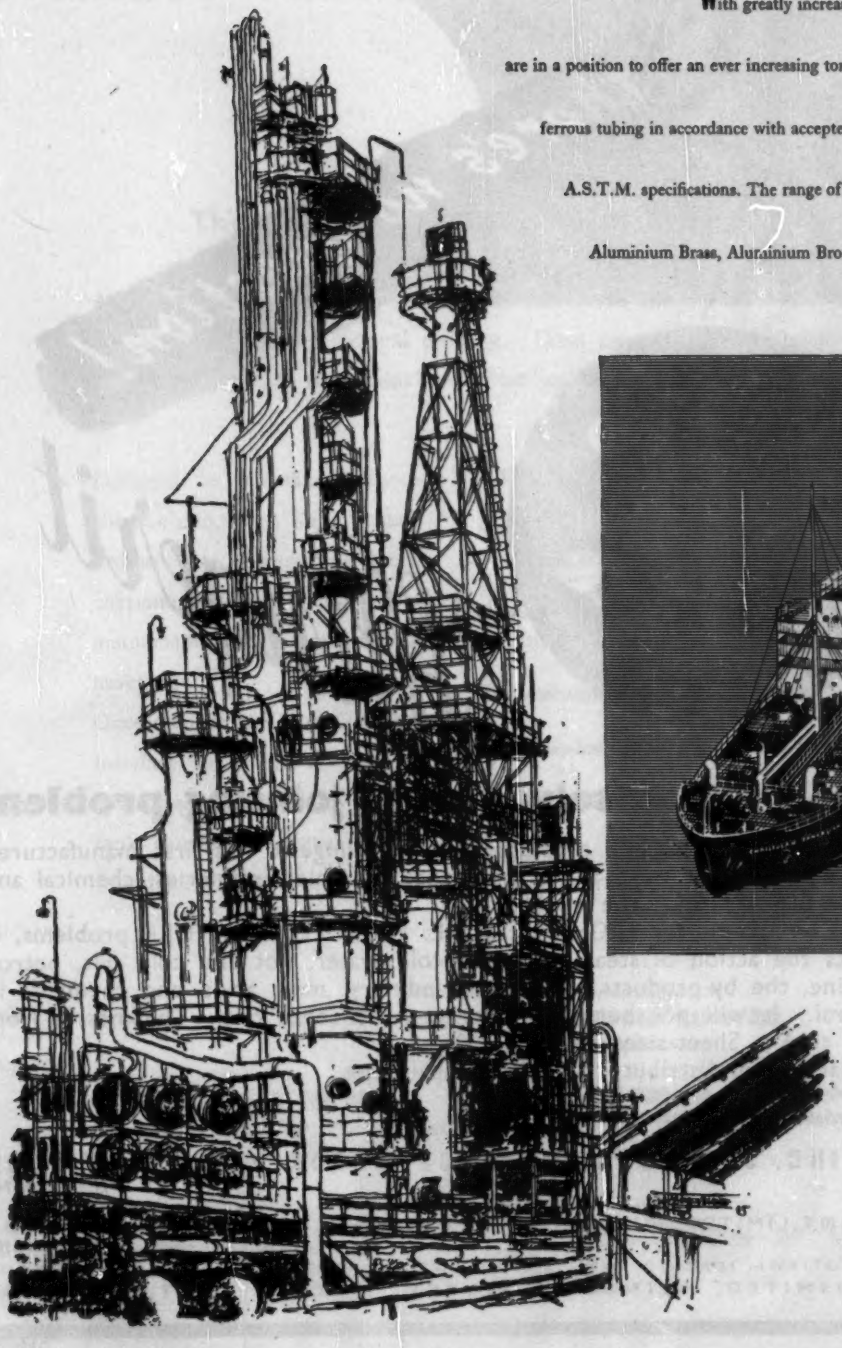
NON-FERROUS TUBES

for the Petroleum Industry

With greatly increased production facilities Serck are in a position to offer an ever increasing tonnage of High Grade Non-ferrous tubing in accordance with accepted British Standard and A.S.T.M. specifications. The range of tubes includes Admiralty Brass, Aluminium Brass, Aluminium Bronze and Cupro-Nickel.



Serck Tubes Limited
Warwick Road
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what's the secret

why is Caposite so strong?

It's no secret why CAPOSITE insulation is so strong and stands up to such rough usage. These pipe sections and blocks are made wholly of Amosite asbestos and the long fibres of this particular kind of asbestos give CAPOSITE its strength and resilience as well as its high insulating value. This exceptional strength leads to many other features besides long life; it means that larger sizes of pipe sections and blocks are possible, making application easier and faster. Less care is needed in handling the material. Unlike other moulded insulation, CAPOSITE, because of its strength, can be shipped to refineries anywhere in the world *in cardboard cartons*, showing big savings in freight and storage costs.

CAPOSITE Regd.

ASBESTOS INSULATION

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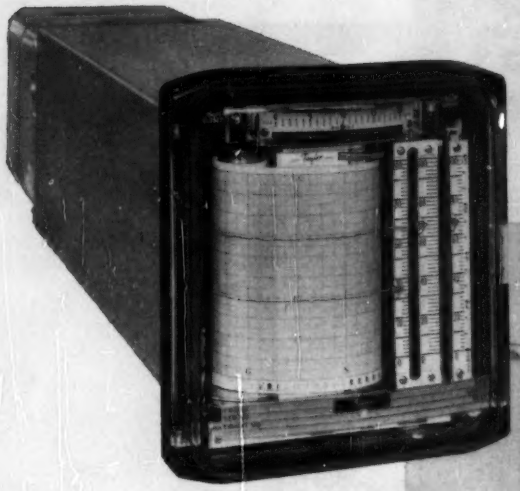
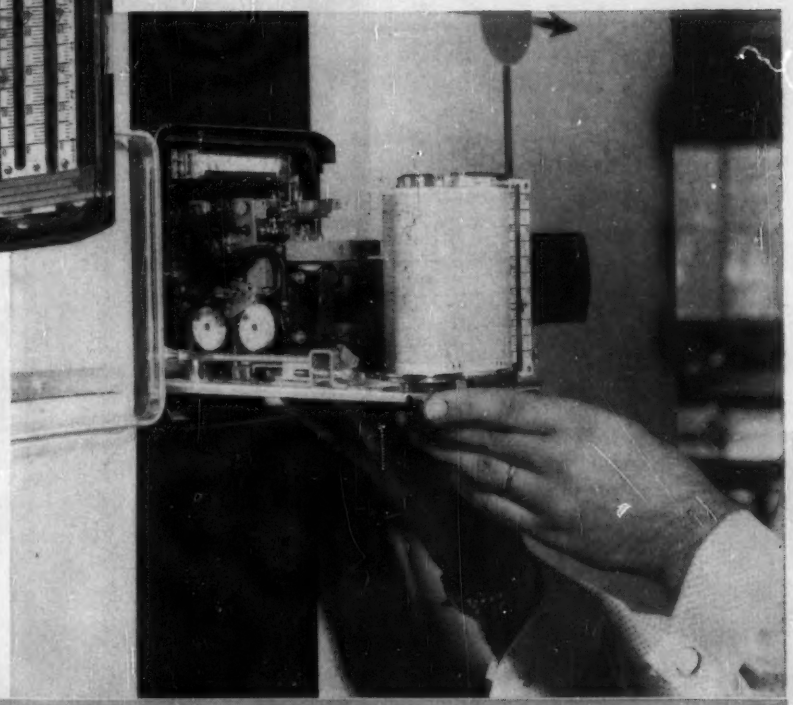
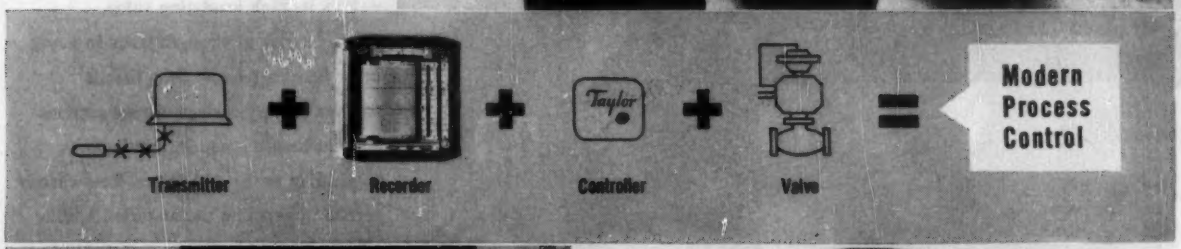
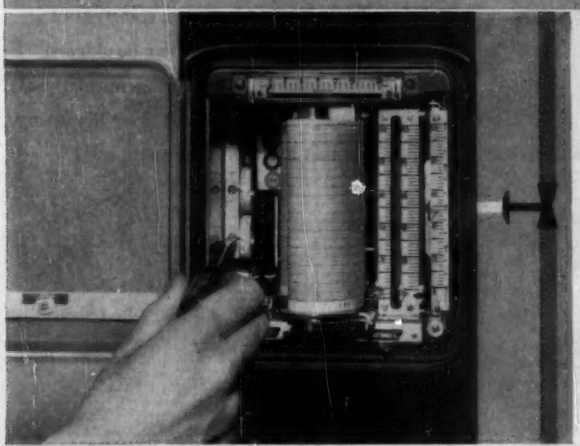


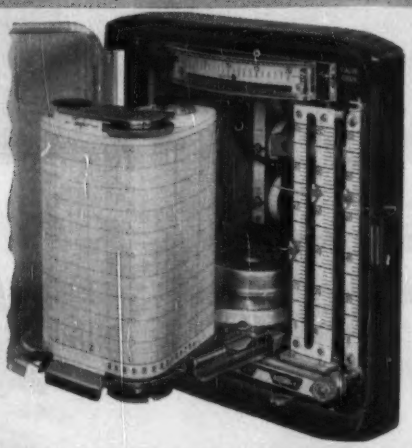


Unique new Taylor TRANSCOPE Recorder plugs into panel-mounted manifold—an integral part of the sleeve. Model shown is the 2 pen recorder with continuous set point, automatic-to-manual switch and output pressure indicator. "Servomatic" power pens provide 150 times more power than conventional bellows-actuated type, assuring life long accuracy.





Controller settings are made from the front while recording. Gain, reset and PRE-ACT* dials are calibrated in specific units. Eliminates blind adjustments—settings and results are seen in one spot . . . the front of the panel.



Most dependable chart drive. Chart is held in positive position and driven by rectangular pins. Timing control is absolute, because chart drum is driven by a Gilmer, chain-like belt. No jerking, because new Rulon bearings cut power needs in half. 4", 30-day chart gives 3 hour visible record.

For more data on advertised products, use Readers' Service Cards, last page.

. . . so Many Features in so Little Panel Space!

Taylor's new 90J Series TRANSCOPE* Recorder is a giant step forward in the development of convenience and compactness for modern instrument panels. No other recorder, regardless of size, puts so many features in so little panel space.

• **Front-of-Panel Control Settings** let you make adjustments easier, quicker, and better . . . from the front of the panel . . . while recording! You can clearly see what you are doing, and the results, because the record is continuous.

• **Stays on Automatic Control** while the recorder is removed for inspection. The unique Set Point Transmitter remains plugged in the case, providing continuous fully automatic control.

• **Complete Indicating Control Station** while recorder is removed. You see the variable. There's no need to shut down the process for instrument service or adjustments. Horizontal gage at top of recorder will show either process variable or air output to valve, as desired.

• **More Accurate Records.** Responsiveness to transmitter output is 0.1%; and because of the very small pneumatic displacement of the input capsule, the response is practically instantaneous. You see more minute process changes, so you can make optimum control setting. SERVOMATIC power pens assure accurate pen position.

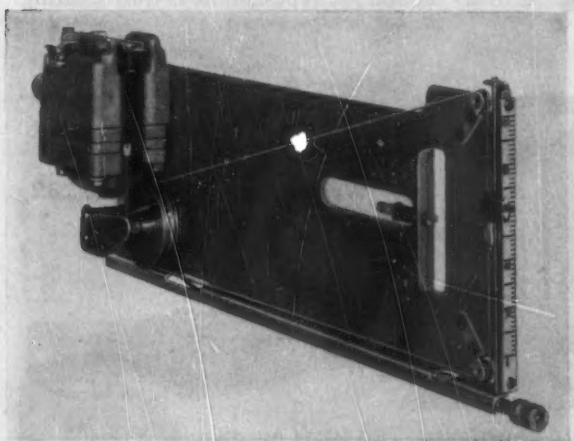
• **Interchangeable Components** — all major assemblies, components and unit parts are completely interchangeable. Both the TRANSCOPE Recorder and Controller may be changed in the field from simplest to most complete form.

• **Receives Three Variables** to be recorded or indicated; has a set point transmitter, an automatic-to-manual switching lever, a cascade or process-output indicator, and many other features . . . all in a compact case.

• **Complete Cascade System** — a complete master-slave combination, in a smaller case than ever before. Perfect for direct control of composition, as well as the usual cascade control applications.

For further information about this revolutionary new recorder, see your Taylor Field Engineer, or write for **Form No. 98282.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Ontario.

*Trade-Mark



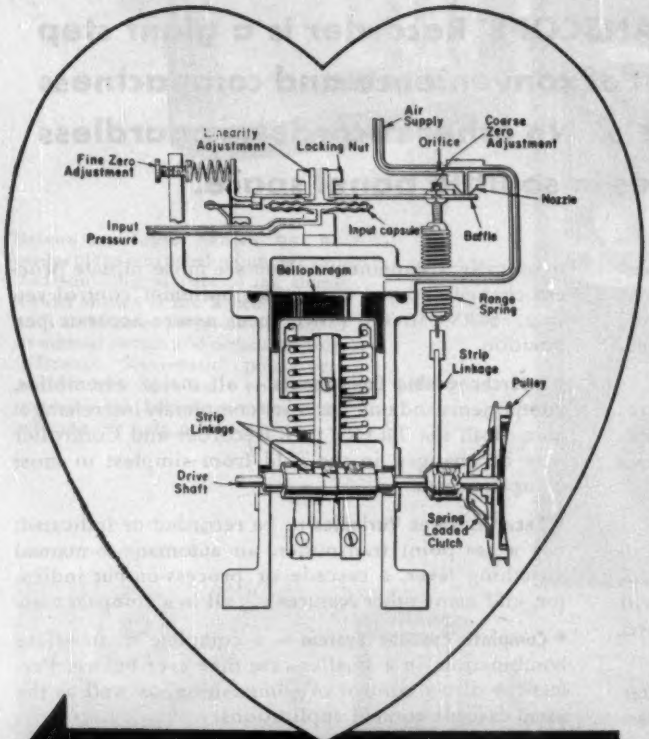
Exclusive "Set Point Transmitter" allows continuous automatic control during recorder removal. The plug-in transmitter assembly may be removed and the control valve sealed in operating position. No need for process down time for instrument inspection or servicing.

SEE NEXT 2 PAGES

Taylor Instruments
MEAN
ACCURACY FIRST

VISION · INGENUITY · DEPENDABILITY

New standards of ...in recording

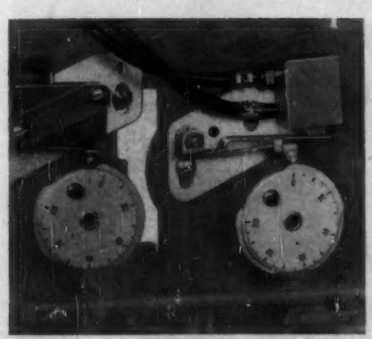


SEE PRECEDING 2 PAGES

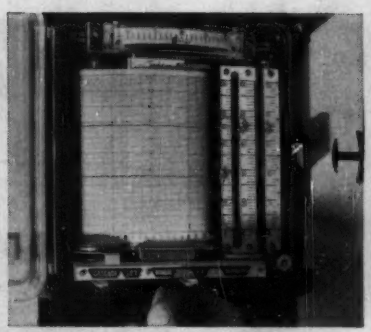
The Revolutionary NEW Taylor TRANSCOPE* Recorder

"SERVOMATIC MOTOR" assures lifetime accuracy of pen position. Transmitter signal is received and amplified by individual force balance servo-mechanisms. Efficient spring feedback and powerful longstroke pneumatic motor give *150 times greater power than normally available for pen positioning.* This means greater accuracy; less service needed. If you like servo-operated devices . . . power steering, power brakes . . . you'll want SERVOMATIC powered pens.

0.1% THRESHOLD SENSITIVITY—A NEW STANDARD OF ACCURACY. Responsiveness to transmitter output is 0.1%; and because of the very small pneumatic displacement of the input capsule, the response is practically instantaneous. You see more minute process changes, enabling you to make optimum control settings to increase yield of specification product. All servos are identical and interchangeable. Servo-pen connection is by means of cable . . . no long, jointed, flimsy links or levers. Allows perfect linear conversion from rotary motion . . . repeatability is truly amazing.



OPTIONAL ALARMS. Each SERVOMATIC motor can operate either an electric or a pneumatic alarm. Each alarm can be adjusted for one high and one low, or two high, or two low operating points. Microswitch on left, air valve on right.



AUTOMATIC-TO-MANUAL SWITCHOVER. Automatic-to-seal-to-manual switching lever gives smooth, bumpless transfer—no air leakage while switching. Incorporates matching of set point to output. Similar lever for Cascade-Set switch.

Write for Form No. 98282

NO MESSY PEN FILLING. 3-months ink supply comes factory sealed in disposable clear plastic cartridge—instantly replaceable. Rides on indicator arm. Powerful SERVOMATIC drive eliminates effects of friction and changing ink supply.

Accuracy ...in controlling!

Taylor TRANSCOPE* Controller is last word in Pneumatic Process Control!

The TRANSCOPE Controller recently announced, and the TRANSCOPE Recorder, described on the preceding three pages, are companion instruments. Together they give you new standards of process control performance . . . unprecedented accuracy and adaptability.

Check these features:

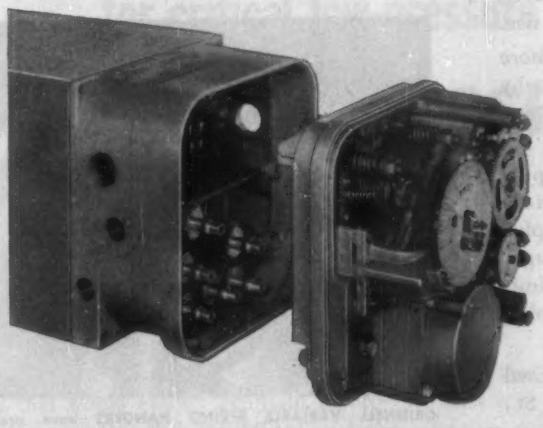
Outstanding performance because it's especially suited for short spans of measurement . . . ideal for time constants of modern processing. It's exceptionally fast and responsive to adjustments, vital on start-ups. Adjustments stay put because precision manufacture of gain, reset and PRE-ACT* units permits predetermined mathematical settings.

Exceptional adaptability to changes in process requirements because components are completely interchangeable . . . in the field . . . in minutes. Instrument action is reversed by merely rotating a dial. It plugs into the TRANSCOPE Recorder or a locally mounted manifold.

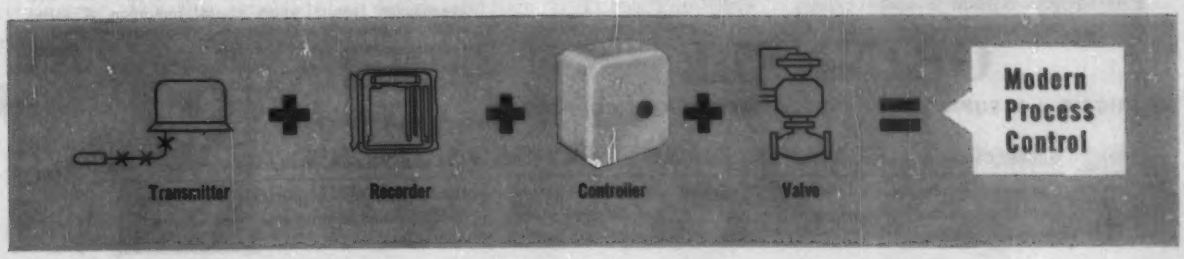
Simple maintenance because it's easy to understand, easy to get at. Rugged bellows assembly, keyed in place, moves the dynamically balanced force plate; friction-free bending member never needs maintenance. Assemblies are of rugged, die-cast aluminum. Stainless steel nozzle and baffle are easily accessible; reaction members of hardened stainless steel. Ball bearing construction gives easy screw-driver alignment. Integral cut-off relay is a built-in feature.

Ask your Taylor Field Engineer, or write for **Bulletin 98278.** Taylor Instrument Companies, Rochester, N.Y., and Toronto, Ontario.

*Trade-Mark

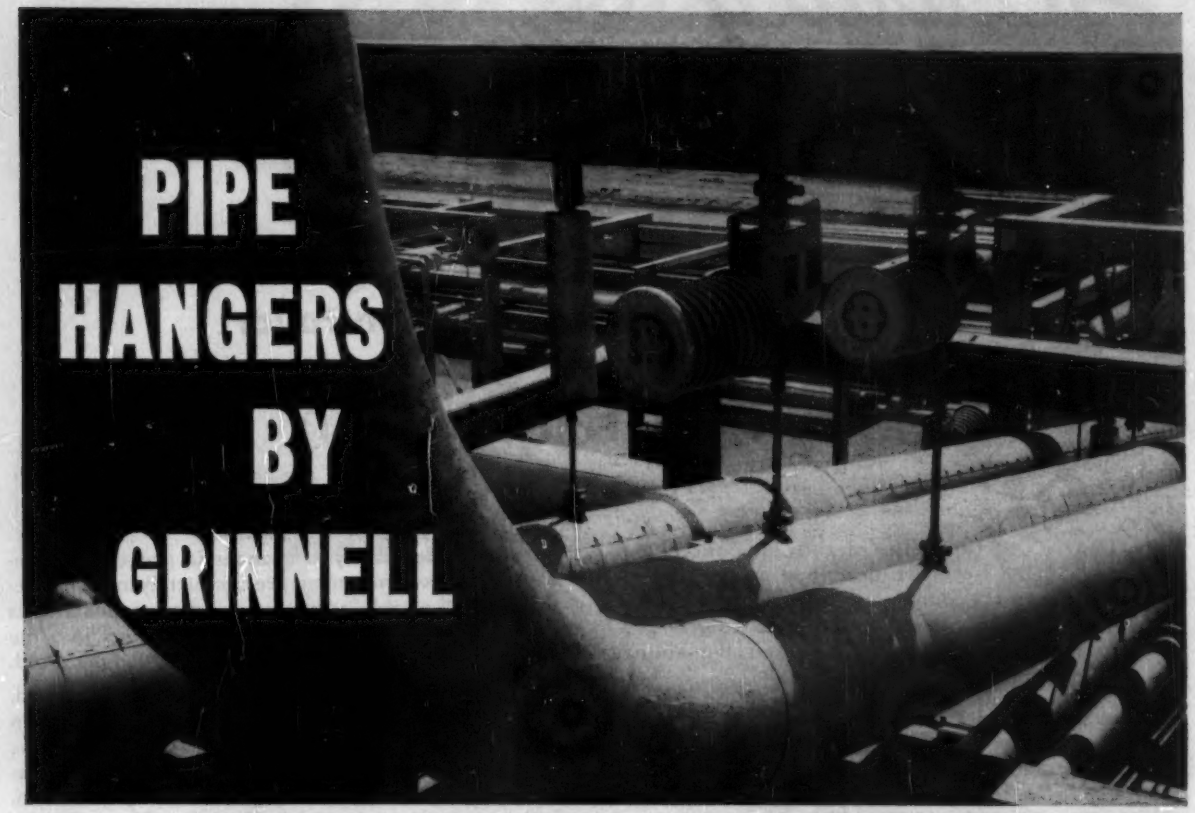


Taylor Instruments
MEAN
ACCURACY, FIRST
VISION · INGENUITY · DEPENDABILITY



For more data on advertised products, use Readers' Service Cards, last page.

At Tidewater's new Delaware Refinery...



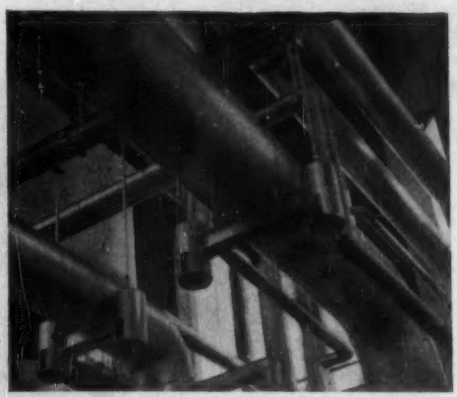
Tidewater Oil Company's new ultramodern $200-million, 5000-acre refinery, south of Wilmington, is the largest ever constructed at one time. Capable of processing 130,000 barrels of crude oil daily, the Delaware Refinery boasts eleven major processing units, including six of world-record size.

Pipe suspension problems, too, were bigger and more challenging at this record-breaking refinery. That's why Tidewater turned to Grinnell, America's #1 supplier of pipe hangers and supports.

A volume producer of pipe hangers, Grinnell backs up its high capacity and diversification with an efficient coast-to-coast network of warehouses and jobbers. Even complex hanger requirements very often can be met with hanger assemblies right off the shelf. This not only saves you time, but it can save you money, by cutting down on the number of special items which must be manufactured.

If you have a pipe suspension problem, you are invited to write: Grinnell Company, Inc., 282 West Exchange St., Providence, Rhode Island.

GRINNELL CONSTANT-SUPPORT HANGERS are engineered to maintain full safety factor. Constancy of support is mathematically perfect for all positions of travel. Note low headroom requirement. Load ranges from 30 lbs. to 32,260 lbs., with travels up to 12 inches.



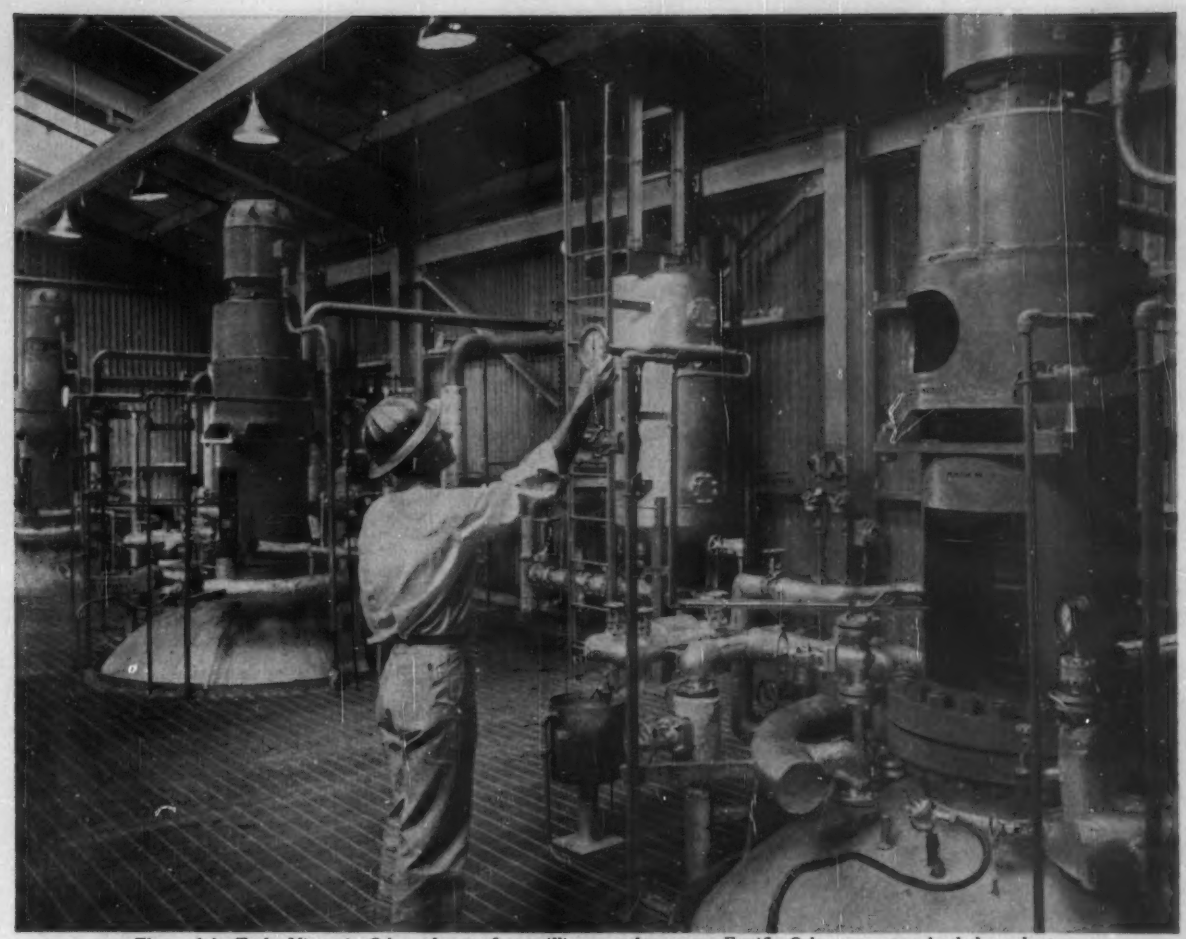
GRINNELL VARIABLE SPRING HANGERS have pre-compression feature which assures operation of spring within its proper working range. Maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes. Available in 21 sizes for loads ranging from 50 lbs. to 28,200 lbs.

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic fire protection systems • Amco air conditioning systems



Three of the Turbo-Mixers in Celanese's new forty-million-pounds-per-year Fortiflex® low-pressure polyethylene plant

for critical low-pressure polyethylene reactors,

CELANESE CHOOSES TURBO-MIXERS

The *formative reaction* is a critical step in the manufacture of Fortiflex®—now being made in the brand-new forty-million-pounds-per-year low-pressure polyethylene plant of the Plastics Division of the Celanese Corporation of America.

For this reaction, Celanese engineers had to have a mixer that would exactly maintain the correct mixing environment. For this reliability in design and performance, Celanese selected Turbo-Mixers. The above-pictured reactors are in the full scale plant (not the pilot plant). Turbo-Mixers serve in many operations in this and other polyethylene plants.

Turbo's 45 years of experience in design . . . Turbo's record of dependability . . . and Turbo's single-source responsibility make the difference. If you're in the process of selecting or specifying mixing equipment, call on Turbo. You'll find . . . *it pays to plan with General American.*

Write for descriptive bulletins.

TURBO-MIXER GENERAL AMERICAN TRADE MARK

TURBO-MIXER DIVISION

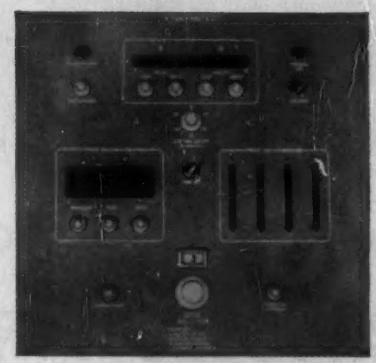
GENERAL AMERICAN TRANSPORTATION CORPORATION

SALES OFFICE: 380 MADISON AVENUE, NEW YORK 17, NEW YORK. General Offices: 135 S. La Salle St., Chicago 90, Illinois. Offices in all principal cities.

For more data on advertised products, use Readers' Service Cards, last page.

Kybernetes data handling equipment proven 99.7% reliable by 37,851* hours of in-plant performance!

* covering the 12 installations made during the past year.



Unmatched accuracy and reliability are achieved and sustained in the Kybernetes Data Handling System by the incorporation of advanced, fully proven techniques. The Kybernetes System provides a new, all electronic concept for the acquisition of process or test information for logging, monitoring and computing. This equipment is designed for accuracies of 0.1% for all inputs, including non-linear types, over extended periods of operation.

The Kybernetes all electronic approach to data handling provides the most direct means of digitizing low level inputs. Discrete counts, proportional in number to the magnitude of the input variables, are stored in digital form ready for direct reading into the printer or display panel. Complex analog to binary encoding and subsequent binary to digital decoding are completely eliminated.

Components having marginal operating characteristics are eliminated from Kybernetes' Data Handling Equipment, which contains no servos, stepping switches or other mechanical operations.

FEATURES OF KYBERNETES DATA SYSTEMS INCLUDE:

A — Provision to record sequential or simultaneous readings of any quantity of inputs.

B — Chopper amplifier with exceptional frequency response, linearity and gain stability as well as high noise rejection and true isolation of input and output circuitry.

C — Individual, hermetically sealed plug-in relay switching providing reliable long term commutating of input signals.

D—Specially developed linearization techniques whereby the generated comparison voltage is characterized to conform exactly to the individual non-linear characteristics of the different types of variables.

E—Plug-in, hermetically sealed components to conform to Class I, Division II requirements for semi-hazardous areas and to provide for ease of maintenance and service.

ON REQUEST: Authoritative Technical Bulletin 108a fully describes latest logging, monitoring and computing equipment. Write for free copy.

KYBERNETES®

Data Handling Equipment for Industry
logging/monitoring/computing

THE KYBERNETES CORPORATION, 9 East 40th Street, New York 16, N. Y. Division of Self Winding Clock Co., Inc.

you can meet any lubrication specification if you

BLEND WITH ENJAY PARATONE®

(VISCOSITY-INDEX IMPROVERS)

Base stocks blended with Enjay Paratone can be compounded into lubricants combining cold-weather quick starting properties with high temperature, low consumption characteristics. These lubricants are *all-season* oils, featuring improved gas mileage. More and more refiners and blenders are relying exclusively on Paratone to produce the high "VI" required in these all-season oils.

Through years of intensive research and development work with automotive manufacturers, Enjay has developed the only *complete line* of high quality additives (Paramins®) that can assure *maximum* performance characteristics. Why not let this experience and know-how work for *you*? Write, wire or phone the Enjay Company.

ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC.. 15 WEST 51st ST., NEW YORK 19, N. Y.

Akron • Boston • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

For more data on advertised products, use Readers' Service Cards, last page.

ISOFLOW FURNACES NOW PROCESSING 300,000 b/d IN CATALYTIC REFORMERS

. . . and more "Isoflows" are being installed in the largest reformers under construction

The continuous production of high octane gasoline by catalytic reforming demands sturdy, efficient, soundly designed equipment. This is especially true of furnaces.

The wide acceptance of Petrochem-Isoflow furnaces is due to their high efficiency, dependable performance even under overload conditions, and their long service life. When you apply all the specifications and operating requirements to direct fired furnace design you'll find Petrochem-Isoflows most economically desirable, by any comparison.

For petroleum, chemical and allied process industries there's a Petrochem-Isoflow furnace for any duty, temperature and efficiency.

The unique design and operating features which have led to the wide acceptance of Petro-Chem furnaces include:

- Uniform Heat Distribution
- Maximum Fuel Efficiency
- Low Pressure Drop
- Low Maintenance
- Zero Air Leakage
- Minimum Ground Space
- Simplicity of Design and Construction
- Short Length of Liquid Travel
- Series, Multipass, all parallel flow
- Excess Draft for High Overload

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

REPRESENTATIVES:
Rawson & Co., Houston & Baton Rouge • Wm. H. Mason Co., Tulsa • Lester Oberholtz, Los Angeles • Faville-Levally, Chicago
D. C. Foster, Pittsburgh • Turbax, Philadelphia • Flagg, Brackett & Durgin, Boston • G. W. Wallace & Co., Denver & Salt Lake City
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G.M.B.H., Dortmund, Germany • Heurtey Italiana S.P.A., Milan, Italy • Birwelco Ltd., Birmingham, England

BEN BUTLER (right), West Coast Production Manager, Borden Company Chemical Division. Left, Bernard Egan, Alaskan Copper & Brass Co., Cooper Alloy distributor for the Pacific Northwest.

BUTLER OF BORDEN CHEMICAL

tells why he buys COOPER ALLOY stainless steel valves

Q. Mr. Butler, why does Borden Company Chemical Division require stainless steel valves?

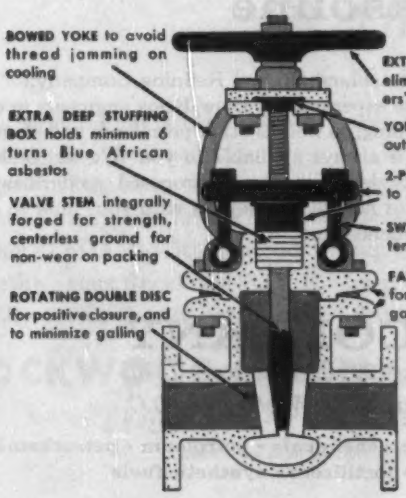
A. In the manufacture of formaldehyde, its derivative resins, and corresponding industrial adhesives only stainless steel can meet our rigid requirements for corrosion, contamination and heat resistance.

Q. What do you consider the most important factor in purchasing valves?

A. The truest measure of a valve is its operating performance. We have never received a complaint on Cooper Alloy valves from our engineers or operating personnel. The extra-large handwheel and unique valve design afford easy operation with positive opening and closing, minimizing maintenance and down time.

Q. What other factors count in choice of valve supplier?

A. Service. The large and complete Cooper Alloy stock at Alaskan Copper affords immediate delivery on stainless steel valves and fittings, as well as pipe. That's a big reason why we buy Cooper Alloy!


BOWED YOKE to avoid thread jamming on cooling
EXTRA DEEP STUFFING BOX holds minimum 6 turns Blue African asbestos
VALVE STEM integrally forged for strength, centerless ground for non-wear on packing
ROTATING DOUBLE DISC for positive closure, and to minimize galling
EXTRA LARGE HANDWHEEL to eliminate need for "persuaders"
YOKE NUT REPLACEABLE without valve disassembly
2-PC. GLAND CONSTRUCTION to prevent scoring of stem
SWINGING EYEBOLTS for maintenance convenience
PAIRED BODY-BONNET FLANGES for equal stress and uniform gasket loading

A VALVE DESIGNED FOR STAINLESS!

The Cooper Alloy valve is not an adaptation of earlier brass and iron patterns. Cooper Alloy, with over 35 years of experience in handling stainless steel, created a valve *designed to be cast in stainless!* **Check the Special Design Features shown at left.**

As the little CA man below is saying: "*You can tell a Cooper Alloy Valve as far as you can see it!*" Write today for *your* copy of our folder "Design Factors In Stainless Steel Valves." The Cooper Alloy distributor near you will be glad to show you the complete line of Cooper Alloy valves *and fittings*, and their advantages. He can serve you promptly from local stocks.

COOPER ALLOY

Corporation • Hillside, New Jersey

VALVE & FITTING DIVISION

THIRTY-FIVE YEARS OF STAINLESS STEEL PIONEERING

For more data on advertised products, use Readers' Service Cards, last page.

AGAIN—Blaw-Knox points the way

. . . this time to ASHLAND's 6,000 bpd source of high octane gasoline

The catalytic reforming and hydrogen desulfurization unit, now in operation, is the latest of eight Blaw-Knox units which are operating successfully in the petroleum industry—to supply high octane gasoline for today's high compression motors. Engineered, constructed and installed by Blaw-Knox, it provides a capacity of 6,000 bpd in the Buffalo Refinery of the Frontier Oil Refining Division of Ashland Oil and Refining Company.

The wide experience of Blaw-Knox engineers in catalytic reforming, as well as other petroleum and chemical processes, is always available to you. We welcome the opportunity to discuss your proposed modernization, expansion or new plant projects with you—and to offer our recommendations.

BLAW-KNOX

BLAW-KNOX COMPANY

Chemical Plants Division • Pittsburgh 22, Pa. • Chicago 1, Ill.

Birmingham • New York • Philadelphia • San Francisco • Washington, D.C.

Designers, engineers and builders of plants for the process industries; chemicals • petroleum • petrochemicals • resins and plastics • nuclear energy • fats and oils • fertilizers • synthetic fuels

HERE ARE THE TEST PHOTOS:

This is a Rockwood Spot Protection System discharging FogFOAM at a pipeline pumping station. Fire could break a link in the pumping system which could interrupt or stop refinery production. The Rockwood System goes off automatically by a rate-of-rise detection system and protects against such an eventuality.

Here's the same scene from another angle after only 3 minutes of the Rockwood Protection System operation! There's a four inch blanket of Rockwood FogFOAM on the floor — and there's no longer any danger of flashfires starting.

Rockwood FOAM delivers four inches of fire protection *in three minutes!*

Rockwood FogFOAM systems *instantly and automatically* discharge FogFOAM to the fire area where it forms a fast flowing heavy blanket of FOAM. Within seconds of the fire's start Rockwood FOAM literally covers the fire and strangles it. Flashbacks are prevented.

Write for full information on how your plant can be spot protected against costly flammable liquid fires by Rockwood precision engineered fire-fighting equipment. Send for your booklet now —

ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses

Distributors in all principal industrial areas

ROCKWOOD SPRINKLER COMPANY
Harlow Street
Worcester 5, Mass.

Please send me your illustrated booklet on Spot Protection Systems.

Name.....

Title.....

Company.....

Street.....

City.....*Zone*...*State*.....

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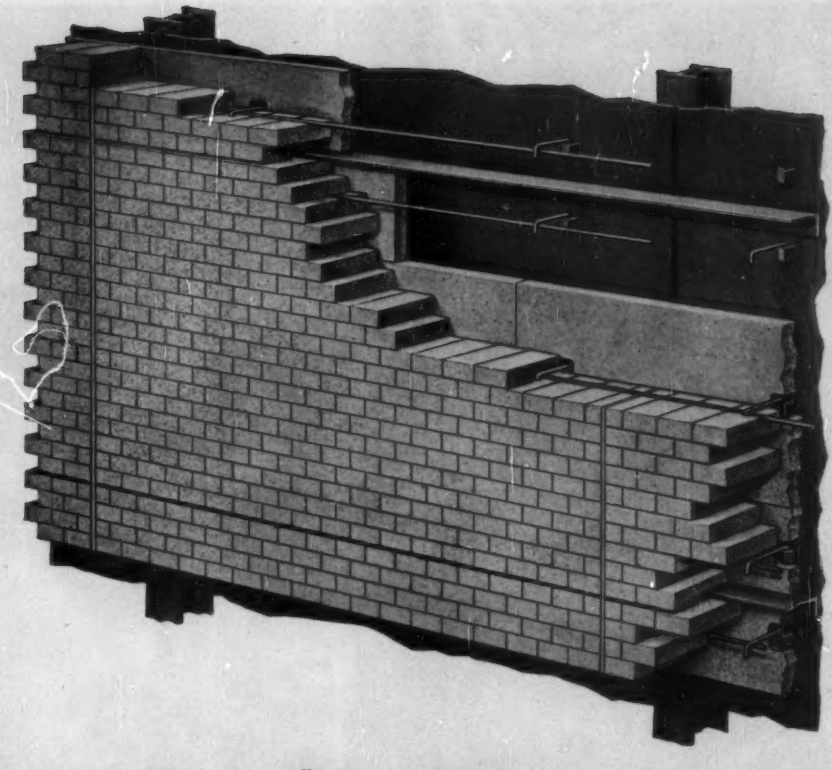


B&W Insulating Firebrick sectionally supported wall construction, horizontal rod-type anchoring

Can this construction cut your costs?

Simplified design and lower material costs in initial construction, ease of installation and maintenance, reduced downtime and economy of operation—these are the benefits of this *lightweight* insulating firebrick construction.

Here's what lightweight means. Compared with dense fireclay refractory materials that weigh from 125 to 140 lb per cu ft, lightweight insulating firebrick weigh approximately 26 lb per cu ft for B&W's 2000 degree brick. This difference provides two major advantages: (1) mechanical, which largely affects design and construction, and (2) thermal, which saves in maintenance, downtime and operation.

Savings in design and construction

The use of lightweight IFB simplifies engineering requirements and reduces costs. A minimum of detailing is needed, since the design is engineered around one standard shape — a feature of B&W IFB constructions.

Material requirements are simplified, too. B&W IFB can be tailor-cut, drilled or shaped as necessary, eliminating the need for costly special fired shapes, and the delays in obtaining them. Typical sections, such as burner openings, observation ports and tube supports, can be cut and shaped on the job in minutes, using ordinary woodworking tools.

Substantial savings are possible in structural steel, since insulating firebrick roof and wall constructions are lighter. In locations with soil of poor load bearing capacities, this lightweight may also result in reduced foundation costs.

These savings, coupled with B&W's engineering and service facilities available during the design phase, mean lower initial costs.

Savings in maintenance, downtime and operation

Lightweight IFB offer a major thermal benefit—they store and conduct less heat. Heavy refractories retain heat; in the event of forced shutdown, they can cause burn-out of expensive alloy tubes, where used. The low quantity of heat stored by B&W IFB can be quickly dissipated, thus protecting these expensive tubes.

Further, this low heat storage permits faster heating and cooling. This means quicker access to the furnace in the event of emergency shutdown. Your maintenance crew can get in the furnace sooner and get it back on stream faster.

Supplied from nearby warehouses

With the use of simplified IFB constructions, refractory repairs can be quickly and easily accomplished with standard shapes from a nearby warehouse. This eliminates costly delays in obtaining special shapes.

Anchoring devices, too, are simplified. Since there are no expensive special castings in B&W IFB constructions, carbon steel or low alloy rods can be used. These are generally available from any local steel warehouse.

Increased efficiency

Generally, the lighter a firebrick the better an insulator it is. Since B&W IFB are the lightest insulating firebrick made, they are the most efficient insulators. Per inch of thickness, B&W IFB provide more insulation than any other refractory material. The result is that for walls of equivalent thickness less heat is lost with B&W IFB. Casing temperatures are lower, thus improving working conditions. This means increased efficiency and reduced operating costs.

R 939

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

For more data on advertised products, use Readers' Service Cards, last page.

UNARCO UNIBESTOS

Yes, UNIBESTOS is better than ever—it's stronger, lasts longer, saves insulation maintenance costs.

What has made UNIBESTOS® the No. 1 pipe insulation? Almost anyone can tell you today! (1) It's so easy to apply; (2) withstands impact, vibration, moisture, fumes; (3) seals itself at joints, needs no caulking; (4) a single layer locks-in more heat than other double-layer insulations; (5) can be removed and re-used, repeatedly, without damage or loss of efficiency. No wonder you'll find this superior protection saving money on large jobs and small.

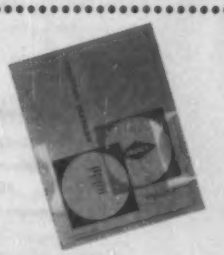
With UNIBESTOS, these savings begin with proper specifications, with helpful technical aid and cooperation from both a competent field service staff and the many UNARCO printed conveniences. We'll be glad to send you any or all of the four shown here. Merely check what you want, and return coupon.

FREE! . . . from Unarco to Insulation Users

NEW UNARCO SLIDE RULE
If selecting pipe insulation is something you do often, you'll save time and avoid errors with this handy, new UNARCO Slide Rule. You should always have one nearby.

AID FOR THE ESTIMATOR
Quick, accurate determination of costs is a mere matter of ready reference with this UNARCO book of "plus values." Shows net prices resulting from plus discounts of 1 to 50%.

UNIBESTOS INSULATION
40 fact-packed pages explain how UNIBESTOS is made, what it is, what it does, why it's better —installation pictures, recommended thicknesses, and size range to 44" o.d.



UNARCO ASBESTOS TEXTILES
Specifications, use recommendations, and how-to-order instructions covering asbestos cloth, tape, tubing, lap, roving, cord, wick, and rope for every conceivable purpose.

UNION ASBESTOS & RUBBER COMPANY
1111 W. Perry Street, Bloomington, Illinois
Please send me free the following items I have checked:

- ☐ UNARCO Slide Rule
- ☐ Book of Plus Values
- ☐ UNIBESTOS Catalog
- ☐ Booklet, "UNARCO Asbestos Textiles."

Individual_____

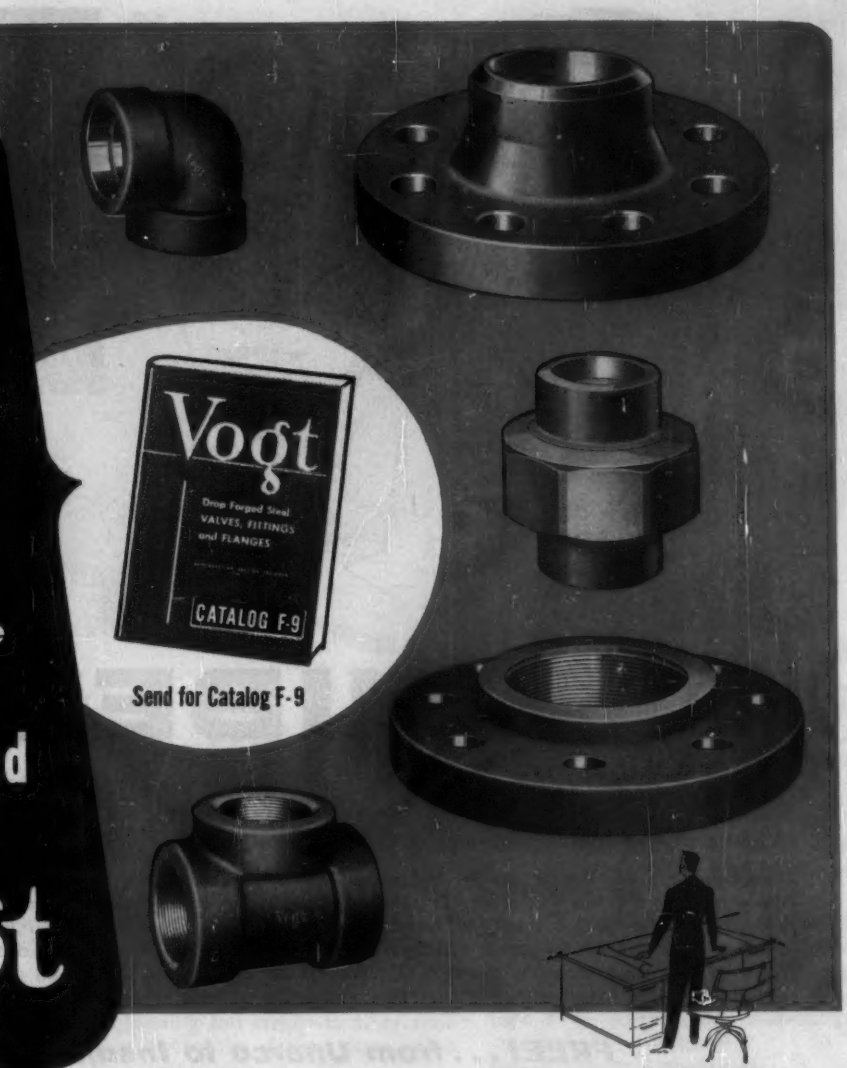
Company_____

Street_____

City, Zone, State_____

STRONGER and SAFER for every high pressure pipeline duty...

...because they are drop forged by Vogt



Send for Catalog F-9

Constantly imitated but never duplicated, Vogt drop forged steel fittings and flanges have unmatched strength and toughness for your most severe pipeline duties. Laboratory controlled materials and Vogt's special forging techniques assure products which are always uniform in structure, fine grained, and free from porosity. Thereby the shocks and stresses imposed by high pressures and high temperatures are easily withstood, and with stubborn resistance to erosion and corrosion. Consult Catalog F-9 for our complete line of fittings and flanges.

For a copy of Vogt Catalog F-9 address Dept. ***24A-FPR.***

OTHER VOGT PRODUCTS

Drop Forged Steel Valves — Petroleum Refinery and Chemical Plant Equipment — Steam Generators — Heat Exchangers — Ice Making and Refrigerating Equipment.

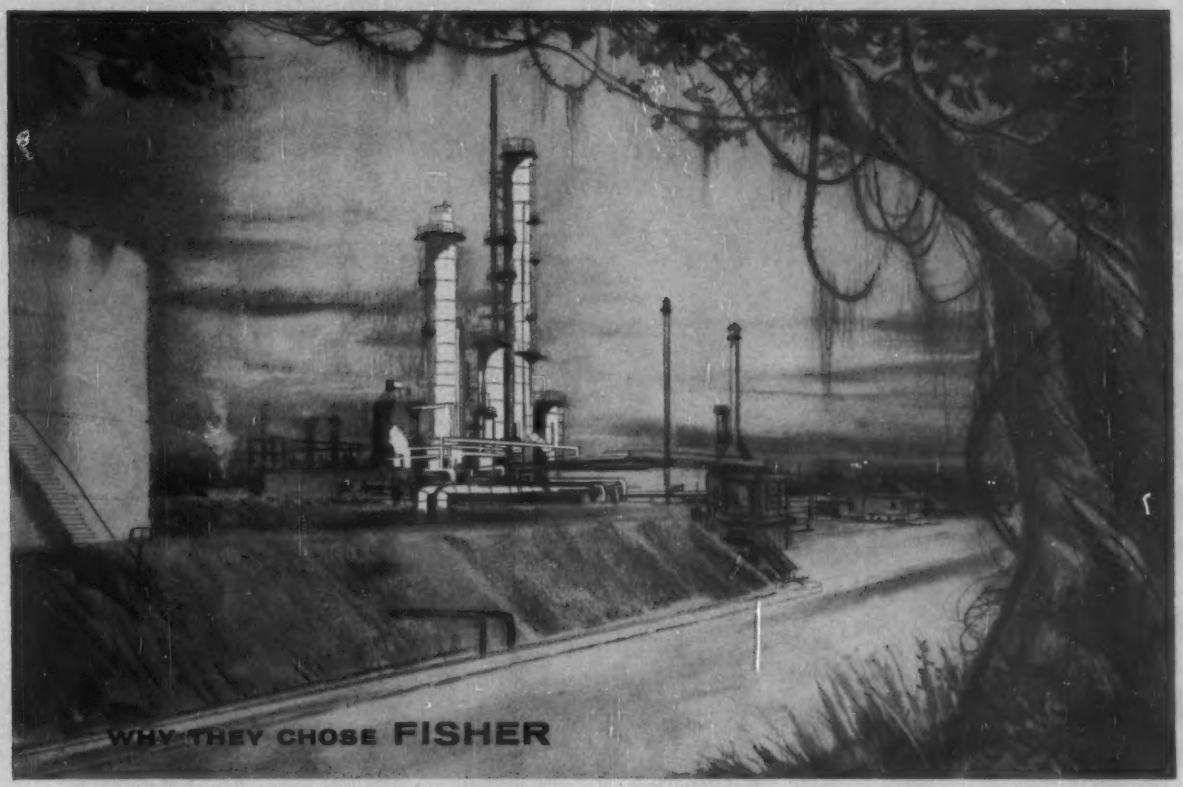
HENRY VOGT MACHINE CO., P.O. BOX 1918, LOUISVILLE 1, KENTUCKY

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J. St. Louis, Charleston, W. Va., Cincinnati

Vogt

DROP FORGED STEEL

Fittings and Flanges



A thousand miles up the Amazon

CONTROLS MUST FUNCTION . . . *WITHOUT PAMPERING!*

A thousand miles up the Amazon puts you about 200 miles south of the Equator—and a whale of a long way from service, as we know it. But, nevertheless, there stands the Manaus Refinaria del Companhia de Petroleo da Amazonia, complete with the most modern refining equipment.

Here, every bit of equipment must stand on its own merit . . . there is no time for pampering. Sources of supply and repair are too far away to help much.

So, when they hacked this refinery out of the jungle, they chose *Fisher* control valves and liquid level controls.

In a recent report, Arturo Amorim, Vice President and Director of Operations, states, " . . . All are delivering excellent performance"!

Which again proves that you can't beat more than three quarters of a century of *Fisher* engineering know-how for day-after-day dependability.

Manaus Refinery
COMPANHIA de PETROLEO da AMAZONIA
Designed by
SOUTHWESTERN ENGINEERING COMPANY
Los Angeles, California
Inaugurated September 6, 1956

Fluid Catalytic Cracking Unit
Designed by
UNIVERSAL OIL PRODUCTS COMPANY
Des Plaines, Illinois

CONTROL VALVES—LIQUID LEVEL CONTROLS
Supplied by
FISHER GOVERNOR COMPANY
Marshalltown, Iowa / Woodstock, Ontario

FISHER GOVERNOR COMPANY
Marshalltown, Iowa / Woodstock, Ontario

FISHER® Controls

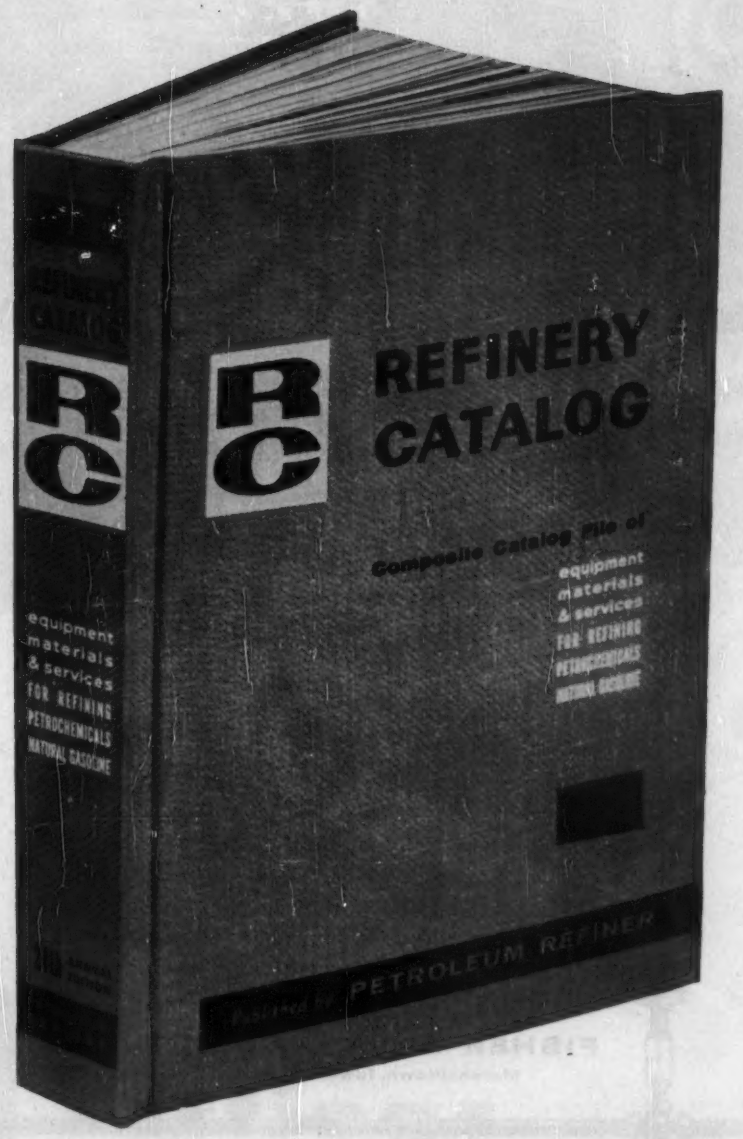
SINCE 1880

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROLS

NOW

BETTER THAN EVER

Here's the REFINERY CATALOG's 1957 Edition, better, more complete than ever before.



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MOST COMPLETE SINGLE SOURCE

..... of Equipment-Service Data in

– Refining

– Natural Gasoline

– Petrochemicals

Completely indexed and cross indexed . . . Saves Time
Refer to it when ordering . . . specifying . . . inquiring

Make your buying job easier, eliminate errors, reach for your copy of the REFINERY CATALOG and watch for quick, efficient results.

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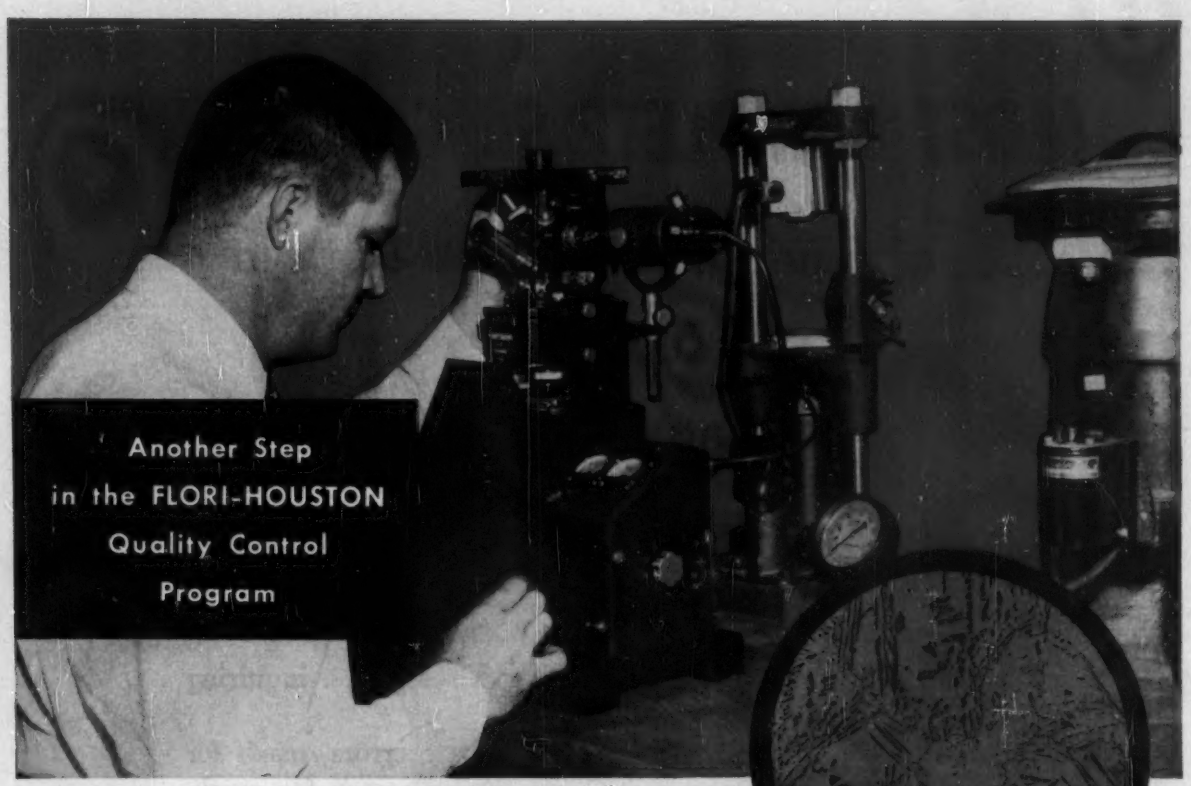


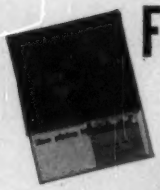
Radiology at FLORI-HOUSTON means better pipe fabrication

Human skills at Flori-Houston are matched with the most modern scientific equipment to insure pipe fabrication of the highest quality possible.

Shown above is a Flori-Houston research and development engineer examining a weld by microscope to study metallurgical structure. Example shown is an aluminum iron alloy for refinery service. This Flori-Houston procedure developed a completely corrosion resistant joint . . . without a backing ring.

Additional inspection of completed jobs is made with Brinnell, X-ray and Magnaflux equipment, to seek out hidden defects which might undermine the strength and dependability of the piping.

It is such strict measures that have made Flori-Houston fabrication synonymous with quality—quality that *you* can rely on for your fabrication needs.



FREE Attractive illustrated 16-page booklet tells the story of Flori-Houston fabrication service. Illustrates equipment, fabrication processes and several interesting "case histories" of Flori-Houston fabrication jobs. Write for your free copy today.

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...bright future for an old flame!

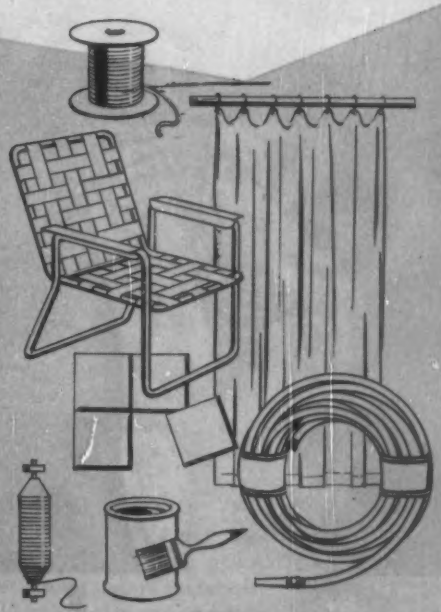
For years the use of acetylene commercially was limited primarily to the welding torch. Today, it is one of the brightest stars on the petrochemical horizon, with some 80% of total output serving as basic raw material for many of the "miracle" synthetic fibres and hundreds of other important plastic products, including *acrylic fibres, resins, solvents,* and *synthetic rubber.*

Key factor in the phenomenal growth of acetylene has been the recent development of processes for its production from natural gas. Among these new production techniques, the BASF process has had the greatest success, because of its commercially proven economy, safety and reliability.

With exclusive rights in all North American countries* for the BASF process, Chemico has designed and constructed facilities for the production of more than 150,000,000 pounds per year capacity of acetylene. This total includes the world's largest plant for producing acetylene from natural gas. This experience enables CHEMICO's highly skilled staff to handle acetylene projects with maximum efficiency and economy.

*On occasion those rights have been extended to other areas, through special arrangement with BASF.

If you are interested in the profit making opportunities offered by acetylene, we suggest you send for CHEMICO's new acetylene brochure (Bulletin No. 257), which will give you more detailed information on the BASF process and CHEMICO's experience in this field.



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CHEMICO

A SUBSIDIARY OF ELECTRIC BOND AND SHARE COMPANY

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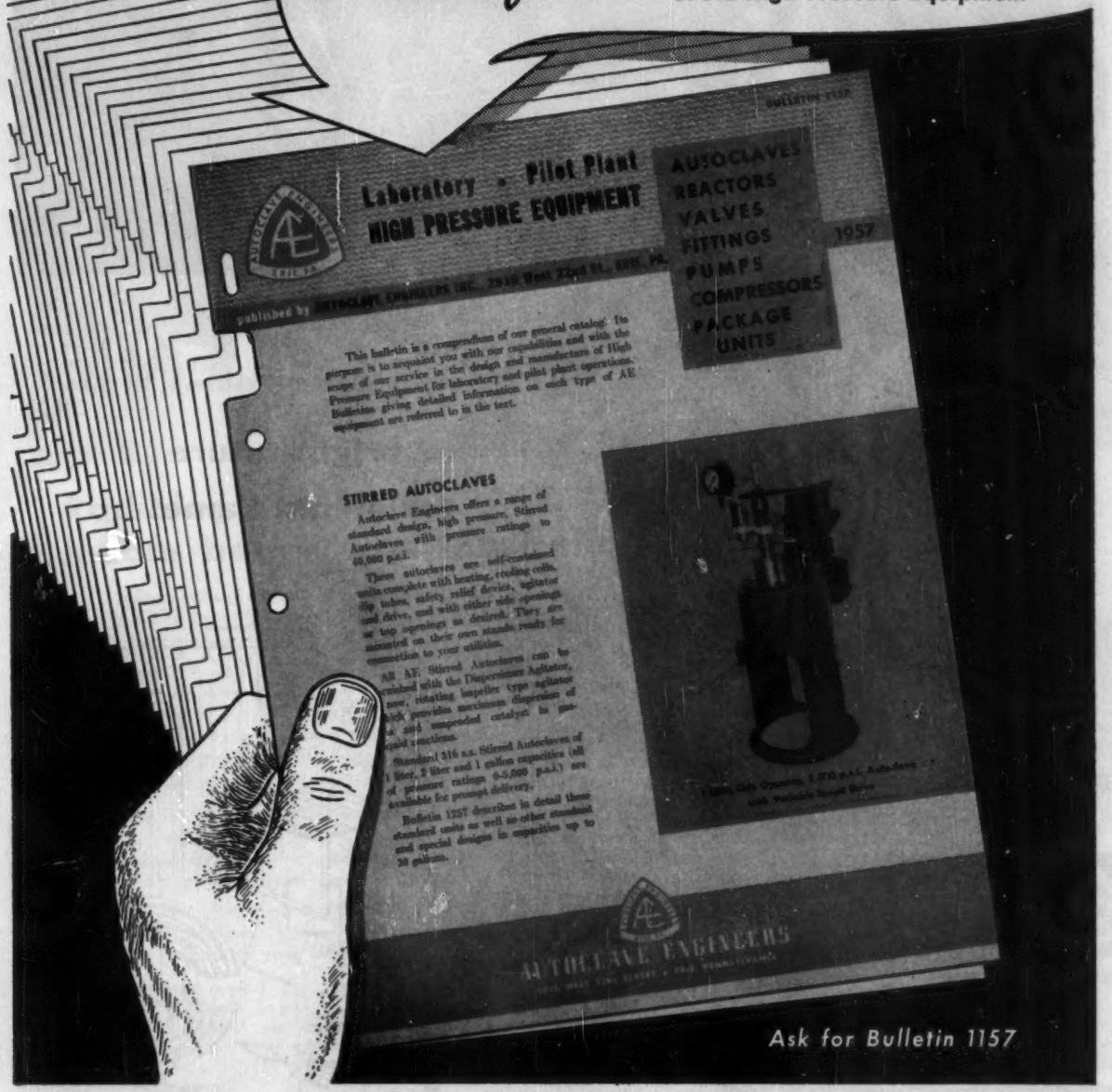
Write for it! A "BRIEF" on the complete line of AE High Pressure Equipment



Ask for Bulletin 1157

Autoclave Engineers

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ACCO
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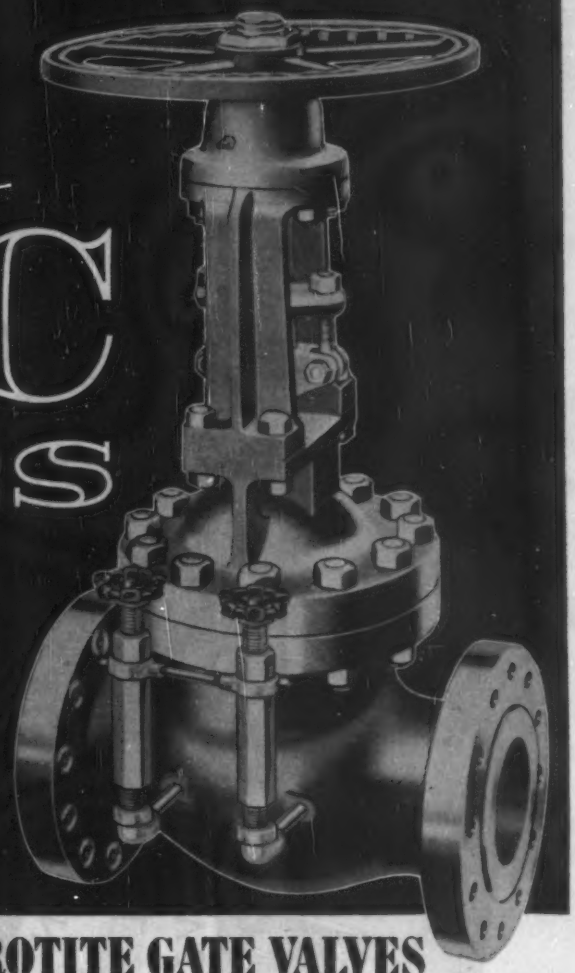
R-P&C VALVES

THE COMPLETE LINE
—DESIGNED FOR DEPENDABILITY



R-P&C "Sure-Tight" LUBROTITE GATE VALVES

—THE MULTI-SERVICE VALVES LUBRICATED THROUGH THE SEAT RINGS

Lubrotite Gate Valves—created and patented by R-P&C—are built to provide absolute tightness and long, trouble-free service in handling all fluids for which iron and cast steel valves are serviceable.

By the unique Lubrotite system, in which each seat ring is served by a Lubrotite gun, a lubricant seal is forced through to the valve's seating surface. This lubricant prevents leakage, retards corrosion, prevents sticking, reduces wear on seating surfaces and makes for easier operation. Net result: reduced operating, maintenance and over-all valve costs!

Available in cast steel and iron types. A wide variety of lubricant seals, each suitable for numerous services, can be furnished.

Lubrotite Gate Valves are giving highly successful service in handling—

Gasoline...Oil...Benzol...HF Alkylation...
other Petroleum Derivatives —

Natural and Artificial Gas...Air...
Helium Gas...Coke and Gas...Water —

Vacuum Service (evaporation, etc.)...
Feed Water Lines and Steam Plants —

Mine and Acid River Waters...
Certain Chemicals...Other Services

Lubrotite Gate Valves form a part of the complete R-P&C line, which includes gate, globe, angle and check valves in all standard materials; all in a wide range of sizes, styles and pressure classes. Order through nearby R-P&C Distributor. Write our Reading office for catalog.

FREE WALL CHART
"How to Protect Your Valves"
Installation pointers, operating tips, clues to longer valve life. They are all on this 22" x 17" wall chart. Write for your free copy.

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Have talents

—will travel

The diversified talents of the men of Parsons are available on a world-wide basis — be they Petroleum or Chemical Engineers; Architect-Engineers for government work; Draftsmen or Construction Crews; Water Development Engineers or Scientists; Procurement Specialists, Inspectors or Expediters; Management Staff or others. The varied projects that Parsons has undertaken throughout the world have given these men the experience which is so necessary in successful overseas operations.

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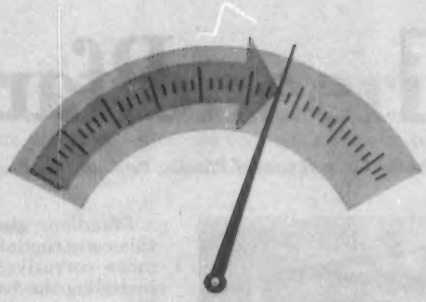

TO STEP UP EFFICIENCY OF SULFONATIONS, SULFATIONS

...USE SULFAN®

(stabilized sulfuric anhydride)

Step up sulfonation efficiency. "Sulfan" has 99.5% SO_3 available for sulfonation reactions. For many applications, "Sulfan" offers nine times as much usable SO_3 as 100% sulfuric acid . . . over three times as much as 20% oleum. This can mean a considerable saving in operating costs.

Step up processing efficiency. With "Sulfan," there is no waste acid. This means that you can increase batch sizes or get more rapid through-put . . . often double without increasing size of equipment! Since no water is formed when "Sulfan" is used for sulfonation, the waste acid problem inherent with use of sulfuric acid or oleum is eliminated.

These benefits alone make "Sulfan" worth your thorough investigation. You may be able to realize other important process economies and advantages too.

"Sulfan" is readily available in tank cars and 750-lb. drums.

Write today for confidential technical information on the use of "Sulfan" in *your* process.

Use "Sulfan" for:

Synthetic Detergents
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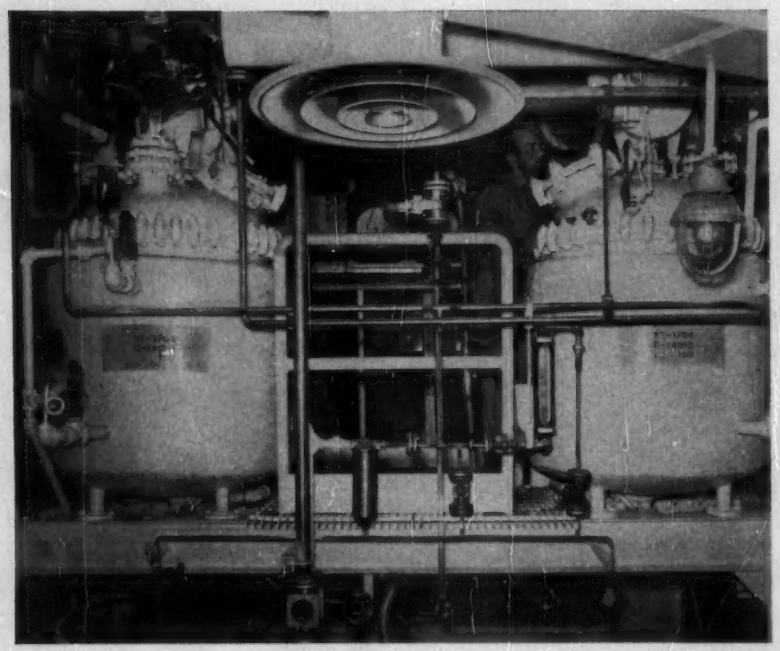
Cut drying time up to 90%. For information on Pfaudler glassed steel dryer-blender, ask for Data Sheet 26.

Pfaudler

Pfaudler Corrosioneering News Published by The Pfaudler Co., a division of Pfaudler Permutit Inc., Rochester, N.Y.



Isolating finished steroids is done in these two Pfaudler glassed steel reactors at Merck & Co.'s Cherokee plant. Absolute cleanliness and corrosion resistance are musts here as in all other parts of complex steroid production which involve several highly corrosive acids. See text.

New MERCK Plant a Classic Study in Corrosive Processing

You're putting a new product into production. Serious corrosion problems are involved. You must justify the need for special equipment in terms of profit return on capital investment. Such were the problems met at the new Merck & Co. plant in Danville, Pa.

The plant makes steroids to pharmaceutical grade specifications. Bromine, hydrobromic acid, chlorine and hydrochloric acid, and a series of organic acids are just a few of the corrosive substances that enter into the complex reactions that produce the steroids.

What sort of equipment do you use to produce steroids that satisfy both the quality controllers and the company comptrollers who expect a fair return on their equipment investment?

Experience is the answer

Because of their long, long experience with corrosives, the men at Merck found that the problem spelled out its own answer: Pfaudler glassed steel equipment.

Bromine, Chlorine and their acids are among the biting corrosives handled by these Pfaudler intermediate series kettles at Merck plant. Merck engineers specified Pfaudler without hesitation, basing their confidence on long experience with Pfaudler glassed steel reactors and storage tanks.

Pfaudler glassed steel because this construction material withstands more corrosives than any other — including the halogens and acid halides mentioned above.

Pfaudler glassed steel because it cannot act as a catalyst itself nor will it release trace metals which might trigger treacherous side reactions.

Pfaudler glassed steel because of ease in cleaning and operational longevity—twenty to thirty years of corrosion-free service in many instances.

Pfaudler glassed steel, finally, because of successful experience—our own 73 years of experience and the experience of companies such as Merck to whom "corrosioneering" is a continuous and profitable study.

Four ways to avoid thermal shock damage to glassed steel

We'd be among the last to ask you to *baby* Pfaudler glassed steel, but we do know for fact that *a little tender care* will help your vessels last longer. Tender care such as this:

One. Keep your operating temperatures below 450°F. unless you consult with our engineering department. This limit can be exceeded but it calls for careful study.

Two. Watch your temperature differentials, especially when dumping a cold charge into a hot vessel.

On *standard* vessels up to 2000 gallons, we usually recommend these temperatures:

Reactor temp.	Charge temp. should be at least	Safe temperature differential
250°F.	50°F.	200°F.
300	125	175
350	200	150
400	270	130
450	335	115

When emptying a hot medium into the jacket of a cold reactor, the difference between jacket and reactor temperature should not exceed the "safe" temperature shown above.

Dumping a hot charge into a cold vessel is not as critical, but we recommend a maximum temperature differential of 200°F. throughout the temperature range at which you normally use the equipment.

The same 200°F. differential holds for injecting a cold medium into the jacket of a reactor. Agitating nozzles and their attached baffles help eliminate thermal shock in such cases by

Corrosioneering News

Quick facts about services and equipment available to help you reduce corrosion and processing costs.

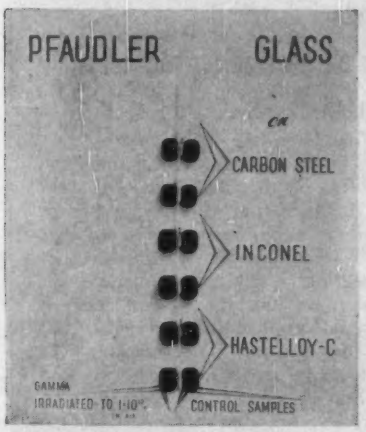
diffusing stream flow and reducing the instantaneous temperature differential.

Three. Be careful when welding or torch cutting. Do not weld to the tank proper under any circumstances. Use electric welding to the jacket, never acetylene. When welding to the jacket sealer, keep at least 2" away from the tank proper. When torch cutting the jacket, cut at an angle to keep flame away from wall of the vessel itself.

Four. Take note of the heat developing from exothermic reactions inside the vessel. Damage to the glass is unlikely unless the reaction gets completely out of hand. For safest operation, however, we recommend that the 200°F. differential be maintained.

Corrosion resistance of glassed steel unimpaired by gamma radiation

No adverse effects could be detected from the exposure of glassed steel to gamma radiation in tests recently completed by Pfaudler in cooperation with Oak Ridge National Laboratory and other installations.



Preliminary evaluations have been completed on the test which exposed glassed samples to a total dose of 10^{10} roentgen from spent fuel elements.

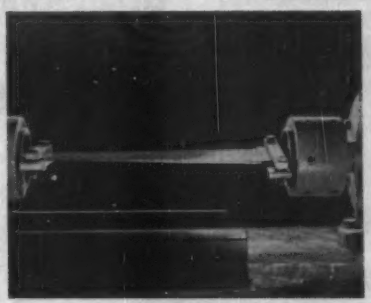
Glassed steel is being considered as a construction material for chemical processing involving nuclear energy wherever corrosive conditions are particularly severe and ease of decontamination is important.

Probable uses of glassed steel in this vast field include storage of acids and other materials which may or may not be radioactive, storage and

continued middle next column

How strong is glassed steel?

We twisted this piece of glassed steel a full 14°, stressing it beyond the elastic limit of the steel itself. Yet the glass-to-steel bond and the glass itself remained intact . . . 100% intact.



This test would satisfy little more than our innate curiosity except for the fact that structural strength is

continued top next column

disposal of radioactive wastes, and chemical processing of highly radioactive and corrosive materials.

Both mechanical and corrosion tests indicate that Pfaudler glass is unaffected by gamma radiation up to 10^{10} r, although a color change does occur. Base metals used included carbon steel, Hastelloy C, and Inconel. The corrosion resistance of the glass did not change with the various base metals employed.

A larger test program is now under way to follow up these early results and to determine more conclusively the effect of radiation on glassed metals.

important in the vessels you buy from Pfaudler.

Why such strength? Three reasons —(1) When the glass and steel are fired at high temperature, the molten glass chemically *etches* the steel, resulting in a powerful chemical and mechanical bond. (2) The compressive forces within the cooled glass toughen the glass and provide a cushion for mechanical and thermal shocks. (3) The "bracing" of the glass by its steel backing.

Now... a glassed pump!

Take a Goulds centrifugal pump and glass its entire interior surfacing and you have a workhorse that assures years of corrosion-free operation at low cost.

The Goulds-Pfaudler pump offers high corrosion resistance to all the common acids except hydrofluoric and mild alkalies.

Write to Goulds Pumps, Inc., Seneca Falls, N. Y., for descriptive bulletin.

THE PFAUDLER CO., a division of PFAUDLER PERMUTIT INC.,
Dept. PR-18, Rochester 3, N.Y.

Please send me: ☐ Bulletin 955, Installation of glassed steel reactors; ☐ Bulletin 947, Buyer's Guide; ☐ Bulletin 892, Structural Strength of glassed steel.

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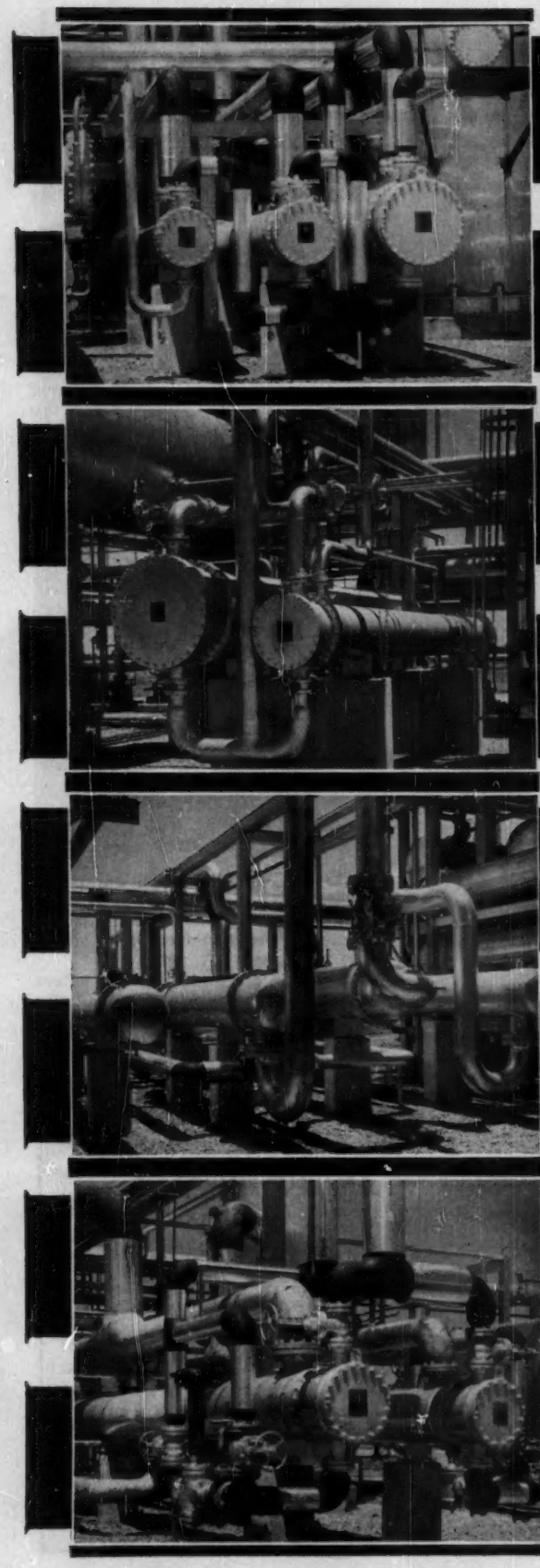


"HEAT EXCHANGERS"

produced and directed by

WESTERN

for

CONTINENTAL OIL CO.'S

Short Junction Plant

Engineered by

TULOMA BUILDERS, INC.

featuring

- absorber inter-cooler
- gas to gas exchangers
- gas to oil exchangers
- inlet gas chiller
- cold oil exchangers
- glycol reboiler
- depropanizer reboiler
- debutanizer reboiler
- rich oil deethanizer reboiler
- lean oil chiller

Western was privileged to furnish the heat exchangers specified for the Continental Oil Short Junction plant in Cleveland County, Oklahoma . . . with all delivery schedules met well in advance.

Western's ability to work closely with the contractor in engineering, designing and manufacturing heat transfer equipment, allowed Tuloma Builders to proceed uninterrupted with the construction plans for the Short Junction plant.

Western's leadership in the manufacturing and distribution of heat exchangers has been built on this capacity for close attention to detail, technical excellence and highest quality.

WESTERN

HEAT EXCHANGERS

WESTERN SUPPLY COMPANY

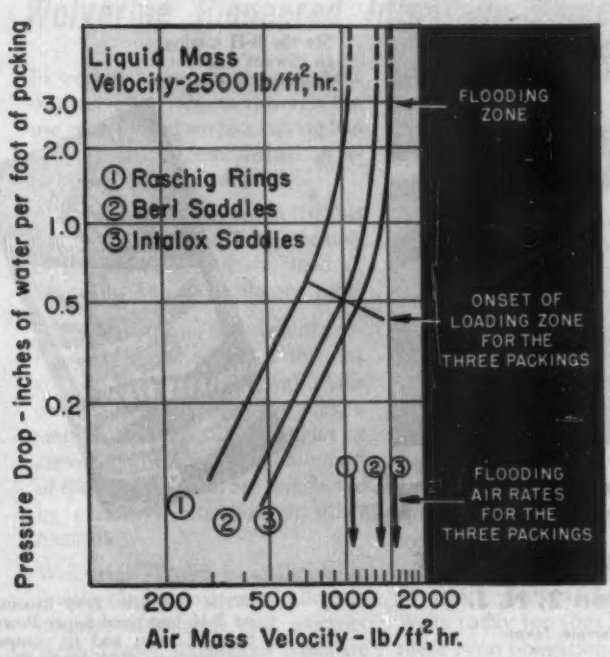
P. O. Box 1888 — Tulsa, Oklahoma

How to increase throughput through your PRESENT packed columns

If your present packed columns are using either Raschig Rings or Berl Saddles you can increase throughput substantially by re-packing your towers with Intalox Saddle packing.

The data in the accompanying chart show typical pressure drop, loading and flooding points for all three packings in the 1" size, all operated under a liquid irrigation rate of 2500 lbs./ft.^{2} hr.

You are ahead with Intalox Saddles in any way you operate your tower. Should you prefer to work substantially below the loading point, say at a gas rate of 500 lbs./ft.^{2} hr., your pressure drop savings as compared to Raschig Rings would be about 65%, and as compared to Berl Saddles, about 25%. Should you wish to operate in the low loading range, as many towers are being operated, you will be able to pass about 50% more gas through the tower, as compared to Raschig Rings; and about 15% more gas as compared to Berl Saddles. And these higher flow rates are realizable at a pressure drop that may actually be lower than you would have with Raschig Rings or Berl Saddles. Of course, the ultimate flooding limits of Intalox Saddles are also higher than for the other packings.



Like to know more about INTALOX SADDLES?

Write for a copy of Bulletin S-29 — full of data every engineer who is concerned with lower cost, more effective packed tower operation needs. Address Dept. The U. S. Stoneware Co., Akron 9, Ohio.

U. S. STONEWARE

AKRON 9, OHIO

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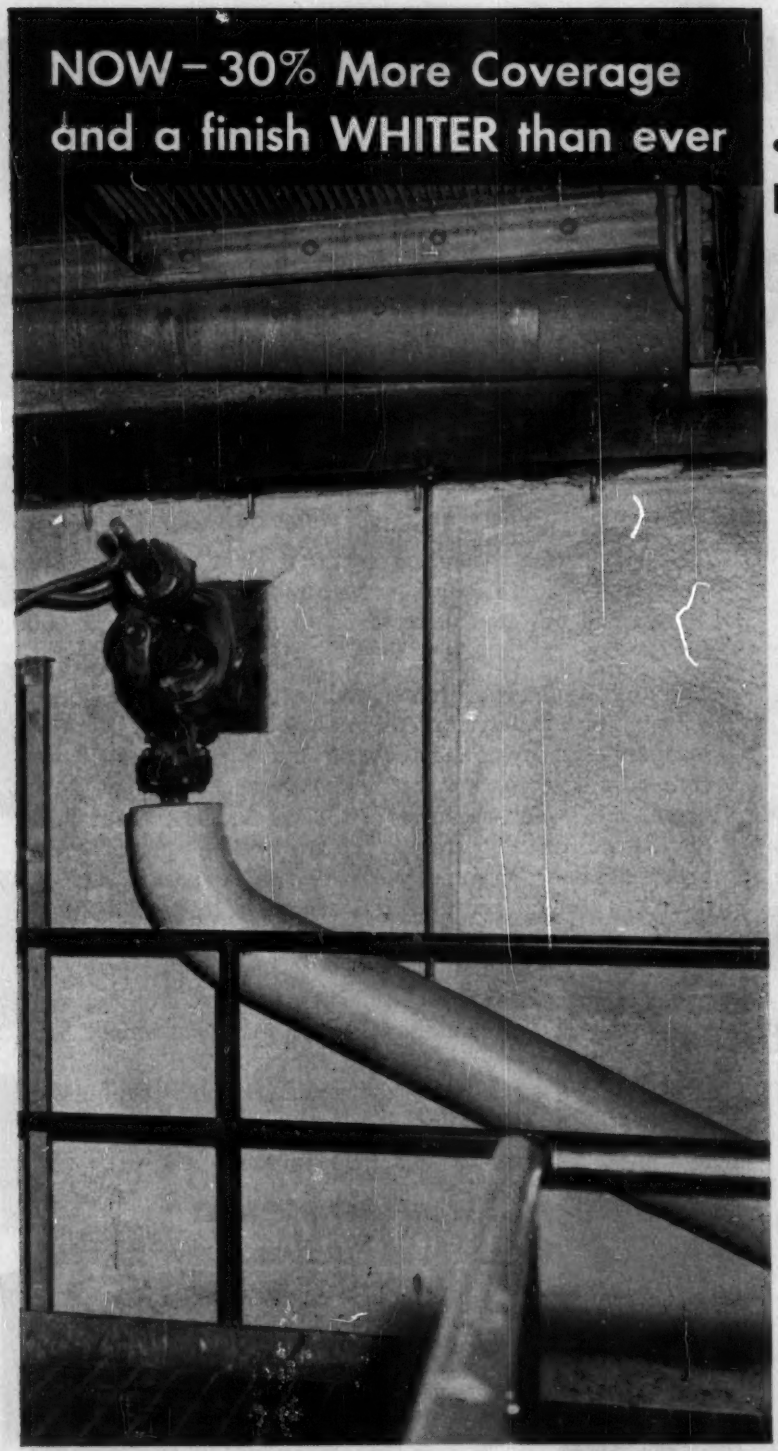

...with
BALDWIN-HILL
IMPROVED
SUPER
POWERHOUSE®
CEMENT

Baldwin-Hill research has developed an IMPROVED Super Powerhouse single-coat, insulating-finishing Cement which provides greatly increased dry coverage — 144 sq. ft., ¼ in. thick or 72 sq. ft., ½ in. thick, per 100 lbs. In addition to greater coverage, shrinkage on drying is negligible, insuring tight joints and freedom from cracks.

The new Improved Super Powerhouse trowels to a high glaze in a bright white finish. And rain, sleet or snow does not adversely affect the cement after setting.

See the B-H catalog in Sweet's Plant Engineering File.

BALDWIN-HILL COMPANY

Complete line of Industrial Insulations

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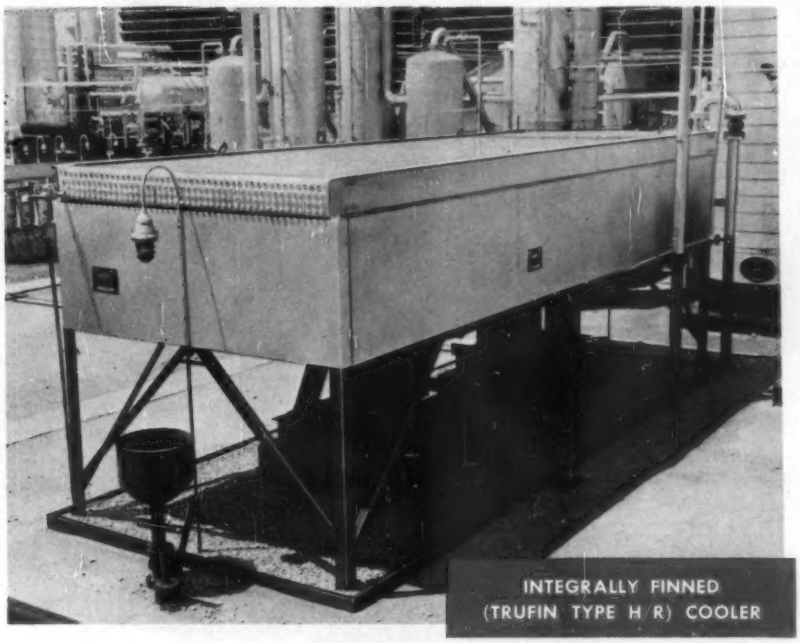
Write for new 1958 brochure on B-H Improved Super Powerhouse Cement and its companion product, B-H Mono-Block.®

WOLVERINE
TUBE
Items of Interest to the Processing Industry

PUBLISHED BY WOLVERINE TUBE

AIR COOLER TUBED WITH WOLVERINE TRUFIN® TYPE H/R



INTEGRALLY FINNED (TRUFIN TYPE H/R) COOLER

BY ERNEST DODD

Of major interest to the processing industry—particularly in those areas where water is scarce or costly—is the operating record of an air cooled Monoethanolamine heat exchanger currently on stream in a West Texas gas plant.

The unit is tubed with Wolverine Trufin Type H/R high-finned aluminum condenser tube and was fabricated by the **Happy Company** of Tulsa, Oklahoma.

Since going on stream in May, 1954, it has operated continuously, effectively and economically in handling a heat load of 4,000,000 btu's per hour in cooling 200 gpm of 8% MEA solution from 160° F. to 120° F. with 100° air at 3000 feet elevation. Coil design pressure is 150 psig at 250° F. The coil is 6-pass and has four rows of 1" O.D. x 24' long aluminum high-finned tubes.

Wolverine Trufin Type H/R is ideally suited for air-cooled operations and proved, in this case, to be the most economical tube in both capital investment and maintenance. Type H/R's ratio of outside to inside surface area is approximately 8:1. It is available in a wide range of sizes in both copper and aluminum.

Because its integral fins are squeezed directly from the tube wall, they have a life expectancy equal to that of the tube —they can never shake loose because of vibration, thermal shock or pressure variations.

Listed on page 4 of this insert are the names, addresses and telephone numbers of Wolverine's highly skilled Technical Sales Representatives. If you want more information about Wolverine Trufin — or if you have a problem concerning the use of finned tube in heat transfer applications just call the one nearest you. There is no obligation.

Wolverine Pioneered Integrally Finned Tube

In recent years, increased heat transfer effectiveness through the use of extended surface tubing has become a well established principle and accomplishment.

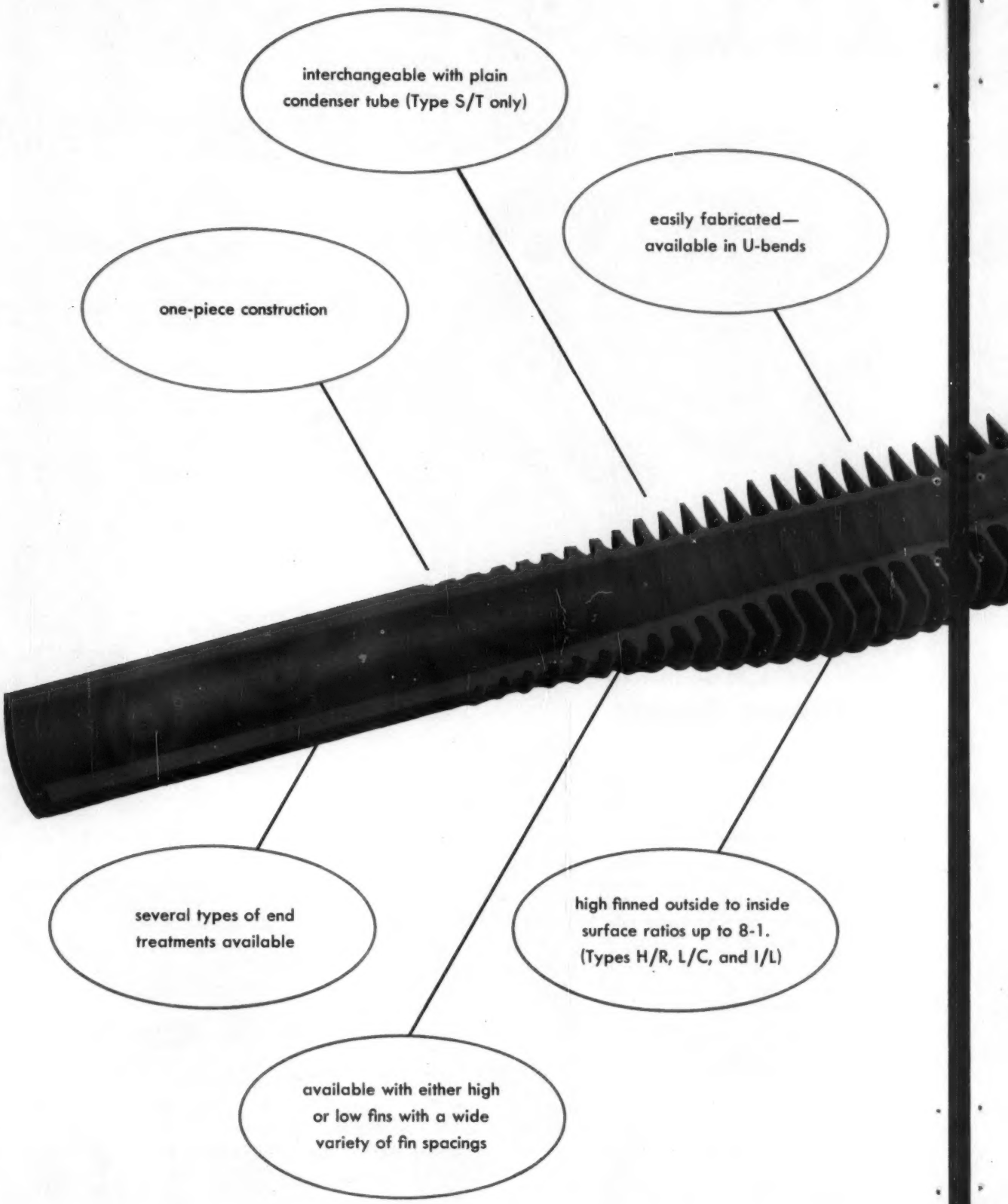
A large share of the credit for this is due to Wolverine Tube because of its pioneering in the field of integrally finned condenser tube.

In manufacturing this type of tubing, Wolverine extrudes the fins spirally from the tube wall. This extrusion process produces a smooth fin minus sharp angles or crevices. The fins are actually part of the tube wall and are unaffected by excessive vibration or other hazards.

Wolverine Trufin is available in a wide range of sizes and alloys in copper, aluminum and electric-welded steel. Its various types are S/T (for shell and tube condensers), H/A, H/R, and L/C (for air cooled use primarily) and Type I/L (a high finned exterior tube with longitudinal interior fins).

TRUFIN CATALOG AVAILABLE—FREE

Wolverine's Trufin Catalog carries complete descriptions of each type of Trufin condenser tube. In addition to sizes, metals and alloys the catalog also describes the various applications where integral finned tube can be used to full advantage. This book is a valuable source of finned tube information —should be in the reference file of every processing engineer. Write today for your free copy—there is no obligation.


interchangeable with plain condenser tube (Type S/T only)
easily fabricated— available in U-bends
one-piece construction
several types of end treatments available
high finned outside to inside surface ratios up to 8-1. (Types H/R, L/C, and I/L)
available with either high or low fins with a wide variety of fin spacings

smooth extruded fins eliminate sharp angles and crevices

fins stand up under thermal shock, vibration and pressure changes

available in copper, copper-base alloys, aluminum and electric-welded steel

more BTU's per foot of tube

THIS IS WOLVERINE TRUFIN!

Look at the advantages—see for yourself what Trufin can do for you. Specify it for new installations and for retubing at turn-around time. You'll do a bigger job . . . boost production . . . save money, too!

Expert Guidance Always Available

These are Wolverine's Technical Sales Representatives—fully qualified men who are ready to help you with your tubing problems.

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TRUFIN HELPS CUT STRUCTURAL WEIGHT

Design of smaller heat exchangers and condensers is now possible because of Wolverine Trufin. This integrally finned condenser tube transfers more BTU's per foot of tube — thus permitting more heat transfer surface to be packed into a given area.

Where overhead units are used, the compact, powerful Trufin units require less structural support—an important feature which contributes substantially to lower costs.

ON STREAM TIME UPPED WITH TRUFIN ON JOB

Designers — when working for the first time with integrally finned condenser tube—sometimes assume that finned tubing should be used only in a clean service.

Nothing could be farther from the truth. The compilation of actual operating data and the results of extensive pilot plant research are proving, instead, that integrally finned Wolverine Trufin actually gives better service than plain tube over longer periods of time.

Comparison tests have shown that when Trufin fouls, the build-up of the scale follows the profile of the fins and tube instead of preferring the valleys between the fins. Thus because Trufin does not present a flat, unbroken surface there is a strong tendency for the scale to fall away which prevents the build-up of an impervious layer.

Write for FREE Book

Actual installations where Wolverine Trufin is being used throughout the processing industries are described in "Wolverine Trufin Process Flowsheet Book".

In addition, this handy book contains information about Wolverine Tube, its facilities and the specialized services it offers its customers.

Processing engineers—both experienced veterans and those just starting their careers—will want to add the Trufin Process Flowsheets Book to their reference files. Write for your copy today.

BUY WOLVERINE TUBE—IT'S MADE IN AMERICA

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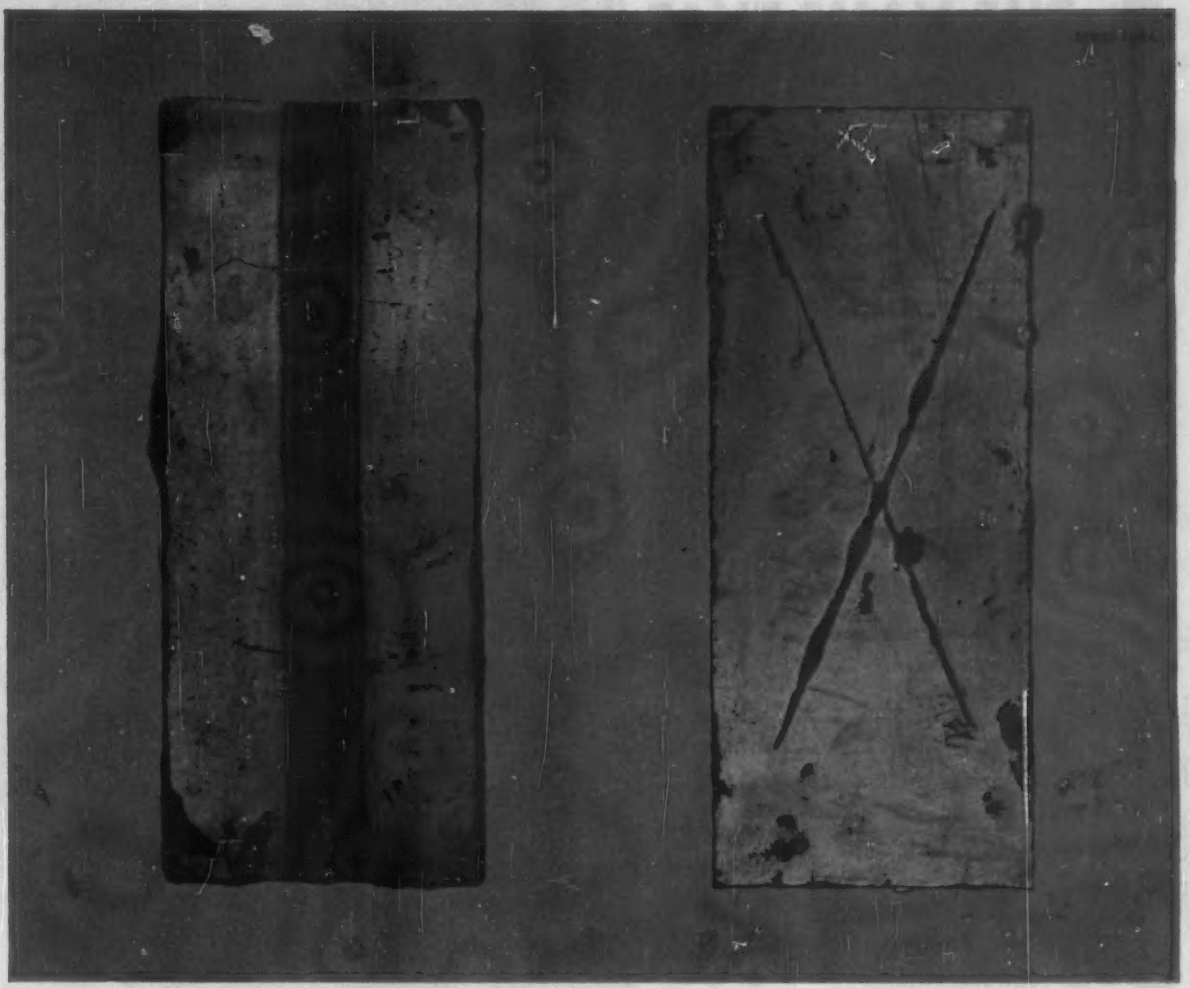
PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES
EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK
Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario



CORROSION'S FOCAL POINTS are easy to detect with a new Amercoat testing method using iron and caustic indicators in a saline gelatin bath. On the welded and scored steel panels shown above after test, unworked surface areas turned red to indicate cathodic properties; but the weld, scores and edges turned blue (here shown blackened) to reveal themselves as anodic corrosion breeders. Rivets, threads, crevices and abrasions also show anodic under test. Unless such areas are effectively sealed from moisture, oxygen and ions they will erupt as focal points of corrosion cells.

How to protect "trouble spots" against corrosion

Ask a corrosion engineer where metal corrosion is likely to attack first. Chances are that he will name rivets, threads, sharp edges, angles, crevices and welds. These are the areas of stress concentration, work hardness, fissures and abrasions. They tend to be anodic and actually breed corrosion. And although they warrant increased protection, conventional coatings pull away from their sharp profiles and leave them inadequately covered.

Amercoat No. 87, a true vinyl mastic, protects these spots in a single coat 10 mils thick, whereas other coatings fail to build 5 mils in three coats. It cuts maintenance painting costs up to 50% because you don't have to re-erect staging and scaffolds for additional coats, and you get results that last.

No. 87 combines the time-tested chemical and weather resistance of vinyl coatings with the thickness of mastic, yet it is easily sprayed with standard equipment over a suitable primer. Available in white, gray, black and aluminum. Use it for enduring protection at lower cost per square foot per year. Complete details mailed on request.—Amercoat Corp., South Gate, Calif.

AMERCOAT Corporation, Dept. VA
4809 Firestone Blvd., South Gate, Calif.

Please send me your latest information on Amercoat No. 87.

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Amercoat® CORPORATION

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For more data on advertised products, use Readers' Service Cards, last page.

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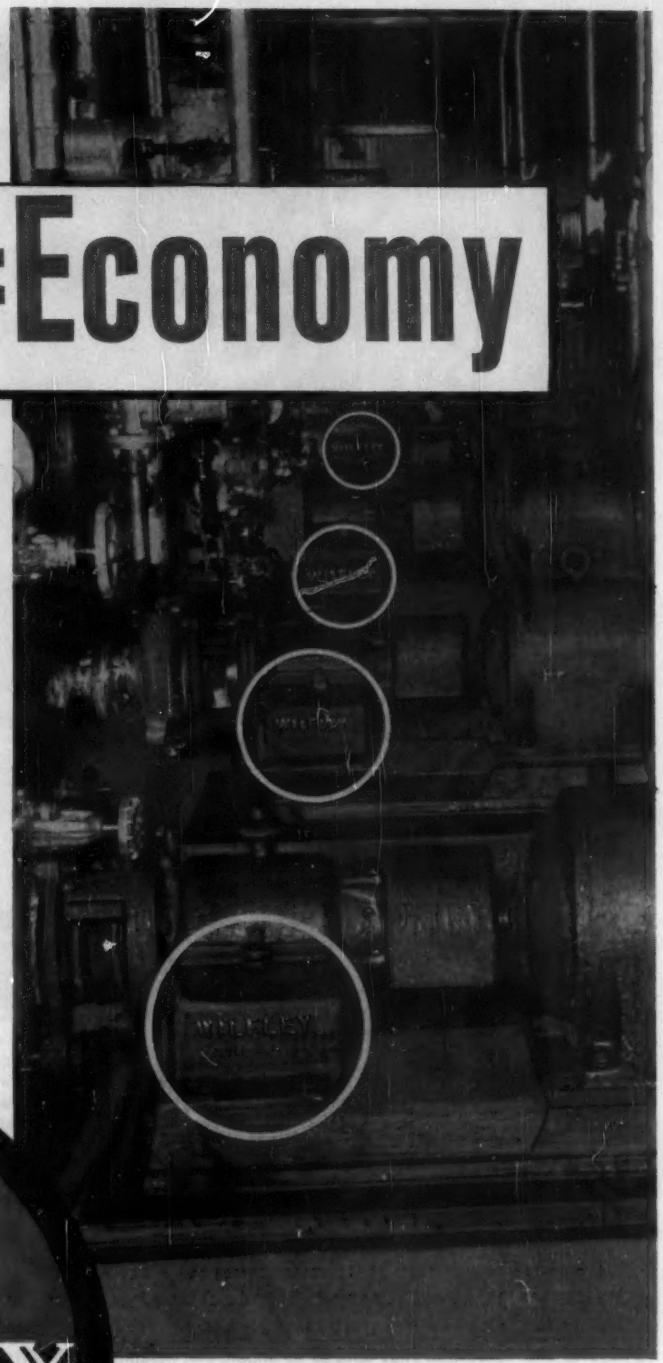
PROVES

Quality=Economy



Pumps that bear the name Wilfley are money savers. Production records consistently prove that Wilfley quality pays off in lower pumping costs. Rugged, heavy-duty construction provides long, trouble-free service on tough as well as easy pumping jobs. Let a Wilfley Acid Pump go to work for you . . . it starts saving money the moment it goes into action. Available with pumping parts of the machinable alloys as well as plastic to meet all requirements.

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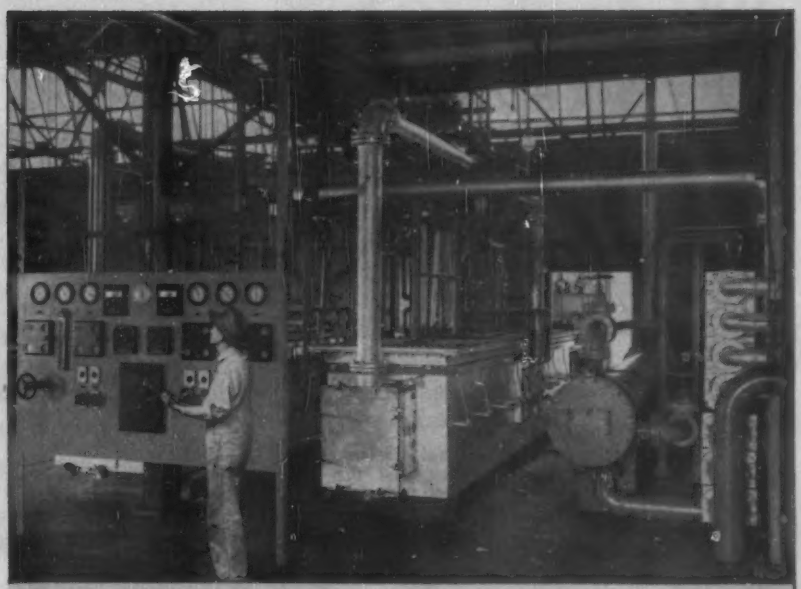
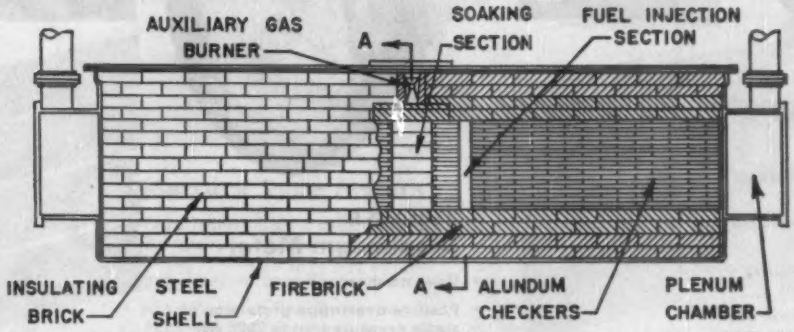
ALUNDUM* checkers give 4 years continuous service

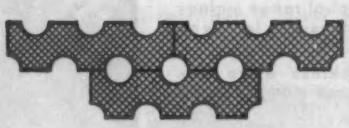


In this double regenerative furnace the Wulff Process Company of Huntington Park, Calif., produces acetylene starting with propane or other petroleum gas as the raw material. The Wulff Company reports that ALUNDUM checkers in this equipment are still going strong after continuous service, five days a week for more than four years.

Wulff Process Company says no replacement required in acetylene producing furnaces



Cross sectional diagram shows, in yellow, the location of Norton ALUNDUM checkers in the Wulff furnace. Air, preheated in the first ALUNDUM regenerator to 1800° F., is mixed with gas in the fuel injection section producing high temperatures and transferring this heat to the second regenerator. A propane-steam mixture is then passed in the opposite direction through the regenerators, heating and cracking in the second and cooling in the first. The heating and cracking cycles are both of one minute duration. ALUNDUM checkers take this extreme cyclic thermal stress and provide efficient, low cost operation.



Tubular passages for preheated flow are formed by ALUNDUM checkers. Their resistance to the erosion of hot gases is extremely important in many installations. Also, their purity is essential. Iron or other impurities could result in harmful side reactions in such gas cracking operations.

Norton refractories, engineered and prescribed for better performance in many types of equipment, provide long life, exceptional hot strength and maximum protection against the mechanical and chemical attacks of a wide variety of fuels. For further facts on these advantages write to NORTON COMPANY, Refractories Division, 460 New Bond Street, Worcester 6, Mass.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON
REFRACTORIES
Engineered... Rx ...Prescribed
Making better products... to make your products better

NORTON PRODUCTS: Abrasives • Grinding Wheels • Grinding Machines • Refractories
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For more data on advertised products, use Readers' Service Cards, last page.

GET THE BEST SOLUTION TO EVERY FLOW

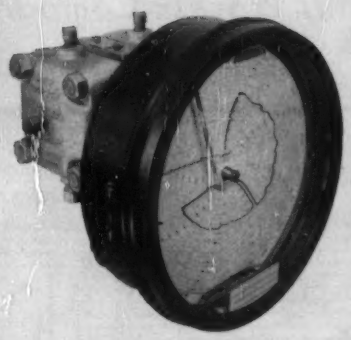
. . . with Foxboro Instrumentation

Differential Pressure Cell Transmitters

Complete line includes air-operated and electric-operated d/p Cell Transmitters covering ranges from 0-20" to 0-850" of water; working pressures up to 4000 psi.

Type 13A d/p Cell Transmitter

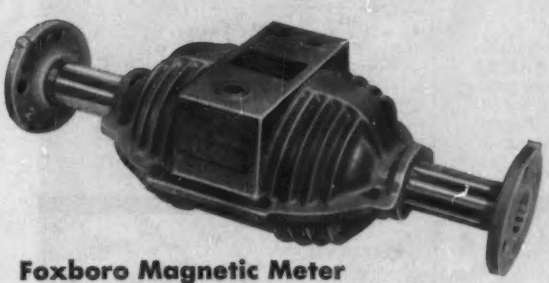
- Positive Overrange Protection—up to full 1500 lbs. rating
- Fully Adjustable Ranges—0-20" to 0-850" water
- Automatic Internal Damping — fast, stable measurement
- Simplicity—easiest, lowest-cost installation, lowest maintenance



Type 37 Diaphragm Meter

- Uses no mercury
- Positive overrange protection at static pressures up to 2000 psi
- Exclusive Features — Built-in temperature compensation never needs change or adjustment; twin-spiral range springs readily accessible for easy range changing
- Unique packless drive bar transmits linear motion to pen arm
- Ranges of 20", 50", 100", 200"; available in round or rectangular cases; 316 stainless or carbon steel body

PROBLEM



Foxboro Magnetic Meter

- Measures Fluid Velocity Directly
- Adds No Pressure Drop
- Uniform Flow Scale
- Overall Accuracy Better than 1% of Range Over Entire Scale
- Full Accuracy Sustained Even on Liquids Other Meters Can't Handle — even sand and water slurries

THERE ARE two logical reasons why Foxboro Instrumentation assures you optimum results in measurement or control of process fluid streams. First: Foxboro offers the widest variety of measuring and controlling devices . . . the right equipment for every application. For example, only Foxboro offers all these basic meter types: differential pressure cell flow transmitters, magnetic meters, mercury meters, and weir meters. Second: Foxboro provides 45 years of engineering experience in every phase of fluid mechanics.

From the simplest general utility-type instrument to complex automatic ratio control systems, you get highest accuracy, efficiency, and economy. Whenever you have a flow problem involving liquids, vapors, gases or slurries — in pipes, ducts, or channels, you can solve it best by specifying Foxboro.

Only a few instruments are described on these pages. For full details, or for specific information on your problem, contact your nearby Foxboro Field Engineer, or write The Foxboro Company, 741 Norfolk St., Foxboro, Mass.

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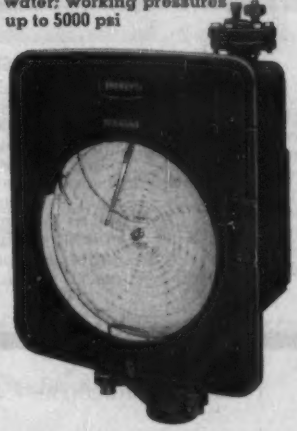
Mercury Type Meters

- Permanent Full-Scale Meter Accuracy — exclusive segmental lever design provides linear transmission from float to pen
- High-Powered Pen Drive—large float with long travel
- Minimum Ambient Temperature Effects — float located in high pressure chamber
- Ranges from 2" to 400" of water; working pressures up to 5000 psi



Other Foxboro Flow Instrumentation

Float-and-Cable Type Meters

Electric or Pneumatic Type Rotameters

Electric, Pneumatic, and Mechanical Integrators

Planimeters

All Primary Elements, Valves, and Accessories required for complete flow measurement and control systems

pumps and mechanical seals for refineries

For special engineering assistance or for further information about Byron Jackson pumps and mechanical seals, contact your nearby BJ sales office or write Byron Jackson Pumps, Inc., P.O. Box 2017 Terminal Annex, Los Angeles 54, Calif.

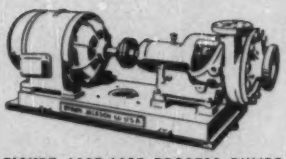
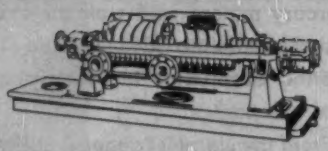


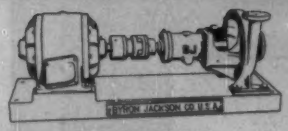
FIGURE 1025-1125 PROCESS PUMPS

Moderately priced pumps for general-purpose handling. Available with BJ Mechanical Seal. Capacities to 2000 gpm, heads to 800 ft. Temperature limit 350°F. Write for Bulletin 353-300.



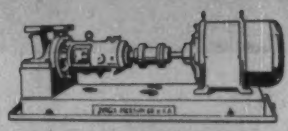
MULTIPLEX PUMPS

Recommended for boiler feed, debarking and all classes of medium-to-high pressure and temperature service. Easy inspection or cleaning without disturbing piping, bearings or driver.



CHEMICAL PUMPS

Specially engineered to handle corrosive liquids. Fitted with BJ Mechanical Seal with all major parts of seal isolated from pumped liquid. Positive protection against leakage to bearings or contamination of pumped liquid.



SM PROCESS PUMPS

For pumping fluids over a wide range of pressures and for temperatures up to 800° F. Ideal for pumping hot or cold liquids near their vapor pressure. Capacities to 4500 gpm and heads to 1900 ft.

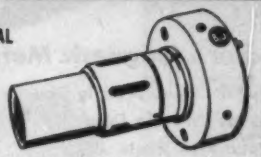
VERTICAL CIRCULATING PUMPS

Single or multi-stage. For pumping medium to high capacities of water. Capacities to 50,000 gpm. Saves space, simplifies piping. For dewatering, drainage, river intake, circulating and sump services.

SMI PROCESS PUMP

This general purpose pump features a BJ mechanical seal as a functional part of its design. It is built for continuous duty and temperatures to 400°F. Easily dismantled and reassembled without disturbing suction or discharge connections. Construction materials to suit application. Sizes: 1½ thru 6" suction, 1 thru 4" discharge. Capacities to 1500 gpm. Heads to 700 ft.

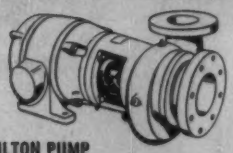
MECHANICAL SEALS



Replace standard packing in stuffingboxes. Eliminate excessive leakage and frequent repacking. Recommended for corrosive, high temperature or volatile liquid pumping. Prevent contamination of pumped liquid.

DOUBLE SUCTION HOT OIL PUMP

Developed for capacities beyond the range of single suction process pumps. Designed to handle high temperature liquids on continuous service operation. Rotating element can be removed as a unit without disturbing the piping or driver. Capacity range from 1000 to 7000 gpm, heads from 100 to 700 feet. Construction materials to suit application.



BILTON PUMP

A general-purpose, close-coupled pump and motor unit. Mounts in any position with no rigid base needed. Especially useful where space is limited. Available with explosion-proof motor. One-third to sixty hp. Capacities to 2000 gpm and heads to 475 ft.

TYPE VMT PUMP

May be designed for pumping liquids from sub-zero to 750° F.—corrosive or non-corrosive—where NPSH is limited. Capacities to 9000 gpm and heads to 575 ft. Smaller standardized (VLT) models also available in capacities to 240 gpm.

SUBMERSIBLE PUMPS

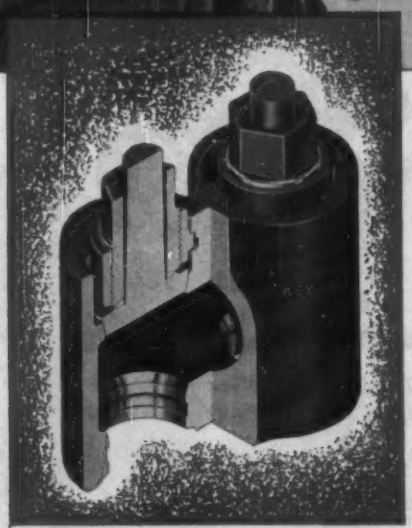
For well pumping, booster stations, or for standby service. Pump and sealed motor operate completely submerged. No pump house or surface structure needed. No well too deep. Ideal where flood menace exists. Capacities to 20,000 gpm and heads to 1800 ft. Write for Bulletins 55-2-700 and 55-3-700.

HYDROPRESS PUMPS

For medium to high pressure pumping at low capacity. Vertical construction saves space, simplifies installation. No relief valves required. Uniform nonpulsating flow. Capacities to 600 gpm. Heads to 10,000 ft.

LIQUID OXYGEN PUMP

Handles liquid oxygen or nitrogen at temperatures as low as −300°F. Insulated section between pump and stuffingbox keeps leakage to a minimum. Standard capacities to 1500 gpm. Heads to 4000 ft. Greater requirements possible by special design.



KEY Fittings have many distinct advantages, including simple design for easier maintenance and repair, fewer parts for less inventory and cost, rugged construction of any desired alloy for long life and safety, ample corrosion allowance, streamlined crossover port for minimum pressure drop and turbulence.

KEY® 5000 TYPE FITTINGS

Serve Socony Mobil Paulsboro Refinery

The heater in this modern refinery is equipped with new patented **KEY** 5000 type return bend fittings. Leading refineries everywhere use these fittings because they offer dependable and lasting service with real economy.

Our Bulletin No. KR-1057 contains complete details about the full line of **KEY** 5000 type fittings. Write now for your free copy.

Address Dept. M-1 for your copy of Bulletin KR 1057 by return mail.

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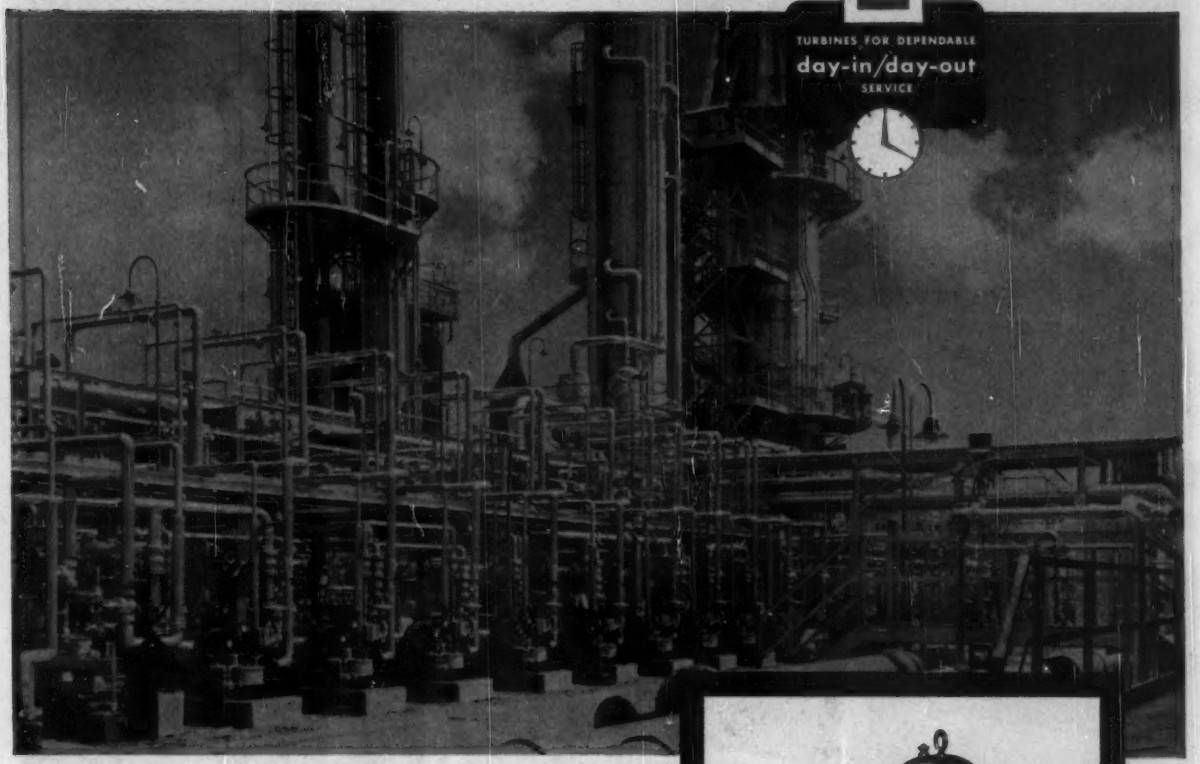

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the best anywhere . . .
serve refineries everywhere

When it comes to prime movers for process and water pumps, fans or compressors, Elliott mechanical drive turbines are the simple and reliable solution. Elliott single-stage turbines, ranging in size from 2 to 600 hp, are specifically designed to provide highest quality and long-term continuous service. In the cat cracker above, a southwestern refinery, 75 Elliott turbines furnish dependable driving power—24 hours a day.

The Elliott YR turbine design also permits easy inspection, simple replacement of wearing parts, and interchangeable components from one turbine frame to another. What's more, your local Elliott field engineer is always available for application engineering or for operating or maintenance assistance. Call today, or write Elliott Company, Steam Turbine Division, Jeannette, Pa. Ask for Bulletin H-22B.

6 design features you get with ELLIOTT YR single-stage turbines

- True Centerline Support for precise alignment, cold or hot, simplifies installation.
- Weather-Proofed, Reliable Governing System with separate overspeed trip and valve.
- Liner Type Bearings, easy to inspect or replace, rapid heat transfer to cooling oil, sealed against elements.
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- Self-Locating Rotor drops into position without adjustments. Entire rotor is dynamically balanced.
- Interchangeable Components permit interchanging of parts between turbine frame sizes, eliminates need for large inventories.

M7-1

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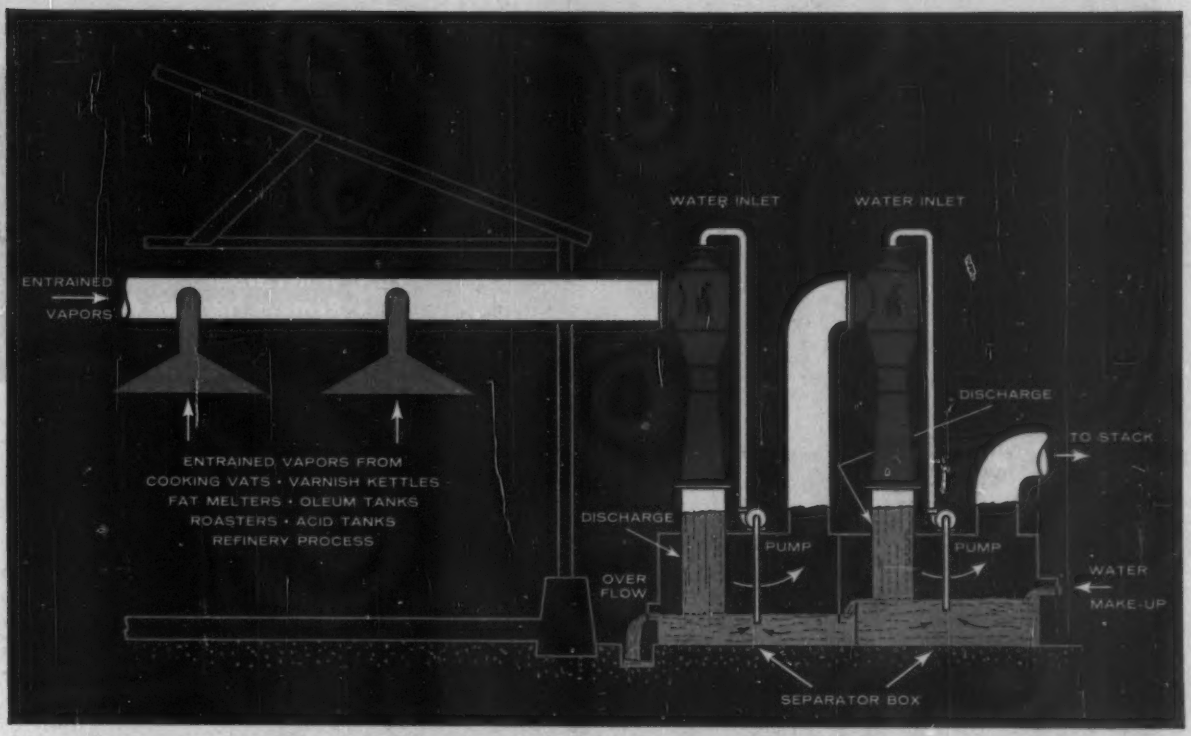

CONTROL OBJECTIONABLE FUMES, GASES, VAPORS

with an economical SK Fume Scrubber

Photo and sectional drawing of an SK Fig. 4010 Fume Scrubber

A food plant in California uses an SK Fume Scrubber to condense steam and scrub oil vapors from cooking vats. A large chemical manufacturing plant on the eastern seaboard uses a battery of SK Fume Scrubbers to condense steam and purge entrained gas containing H_2SO_4, SO_2, H_2S, TiO_2, and ore dust. A mid-western manufacturer uses SK Fume Scrubbers to vent oleum tanks. A soap maker in Pennsylvania uses a scrubber to remove ammonia fumes from a plant building and cool the building at the same time.

From coast to coast, chemical and food processing plants, refineries, paint and varnish manufacturers, fertilizer, and other manufacturing plants are using SK Fume Scrubbers to control objectionable—sometimes dangerous—fumes, gases, vapors, and dusts.

These manufacturers have found that SK Fume Scrubbers are reasonably low in initial cost, require little maintenance, and are an effective means for conforming to local ordinances which prohibit the pollution of air.

Made in a wide range of sizes from cast iron, steel plate, Haveg, stoneware, or other materials or with linings of rubber or Polyvinyl Chloride, or other synthetic materials, SK Fume Scrubbers can help you solve a fume or dust problem. Why not get the whole story. Send for Bulletin 4R which contains complete information on SK Fume Scrubbers.

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ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin 16-RA.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin 17-A.

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COMPANY
MANUFACTURING ENGINEERS SINCE 1876
2257 State Road, Cornwells Heights, Bucks County, Pa.

For more data on advertised products, use Readers' Service Cards, last page.

YOU CAN SAVE UP TO 70%...

ON INSTALLATION COSTS

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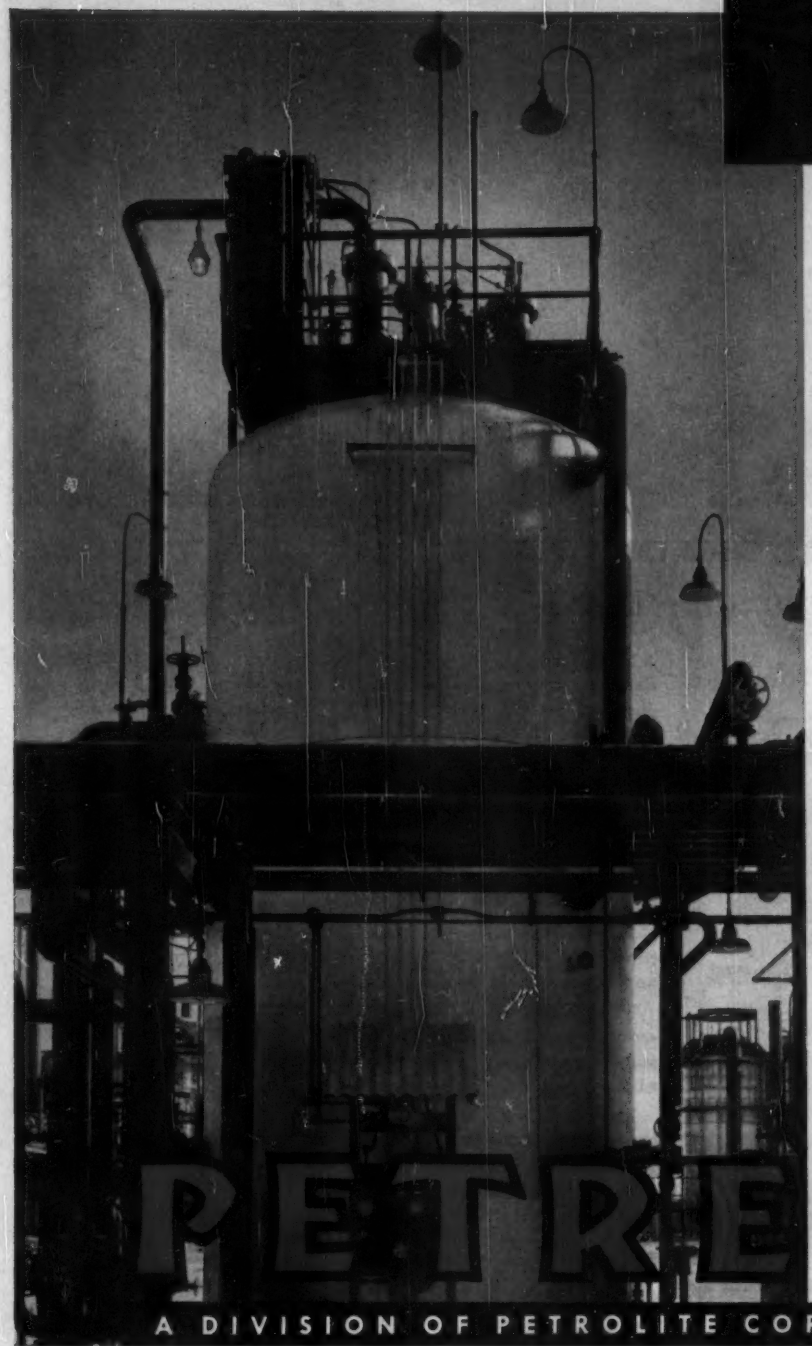
- Acid Treat
- Doctor Treat
- Water Wash
- Remove Nitrogen & Arsenic



by installing PETRECO ELECTROFINING

Petreco Electrofining equipment can easily save you up to 70% on installation. The reasons are readily apparent: it's a once-through, single unit installation that requires fewer pumps, less piping, smaller area.

...and also save on operating costs

because it's a continuous, automatic process in which the distillate is contacted with exactly the *right amount* of treating agent, in the *correct intensity* for the proper time. The result is a clean separation of hydrocarbon and chemical agent, with a minimum carry-over and product loss.

WE'D LIKE TO TELL YOU MORE

about the Petreco Electrofining Process ...and we do in our new Bulletin. Write for your free copy.

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SPECIALIZED ELECTRIC PETROLEUM TREATING

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Visco Laboratory Reports

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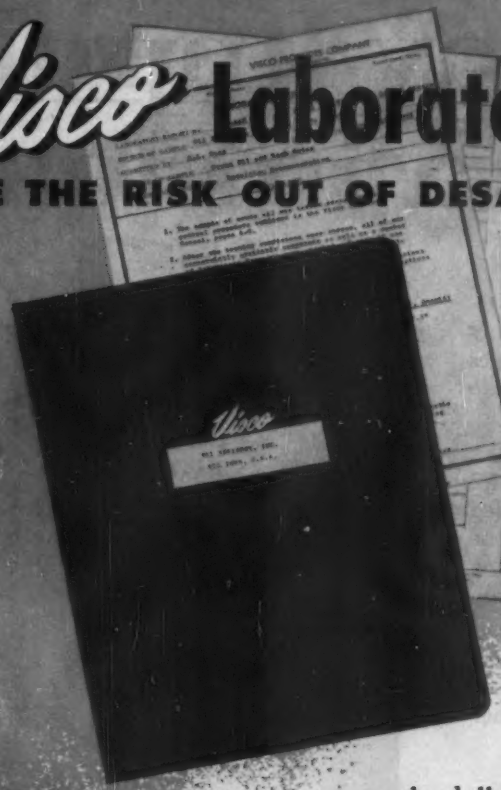
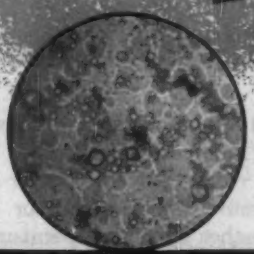


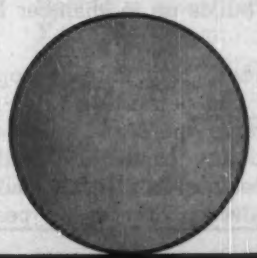
No one knows better than you the dollar loss from a poor desalting set-up.

And you know, too, there's no such thing as a blanket cure-all. But a Visco Laboratory Report *does* point the way to the results you want—from every type of crude—at no added cost to you.



Photomicrograph—
Emulsified refinery crude

In a typical case, 20 or more separate desalting compounds and laboratory formulas may be checked and all contributing factors will be considered before the final desalting recommendation is made.



Photomicrograph—Emulsified refinery crude after Visco desalting

If you would like our desalting recommendation for your crude, send Visco a five-gallon can of the crude and one gallon of the water used in your refinery desalting. Or better yet, check with your Visco representative, and he will arrange for these services.

VISCO PRODUCTS COMPANY
INCORPORATED
1020 Holcombe Blvd. • Houston 25, Texas • Telephone JAckson 8-2495

Visco® CONSISTENTLY EFFICIENT OIL INDUSTRY CHEMICALS

The Yarway Impulse a new era in steam

. . . it began in 1935, when Yarway applied a unique principle of thermodynamics to steam traps—and the Yarway IMPULSE Steam Trap was born.

Since then over 1,225,000 Yarway IMPULSE traps have proved themselves so well in service that today many other type traps are regarded as obsolete—an understandable reason why the Yarway IMPULSE type of steam trap is being imitated.

To industry, the Yarway IMPULSE trap makes possible a new high in thermal efficiency of equipment, a new low in trap operating maintenance . . . resulting in increased production and higher profits for the user.

THE THERMODYNAMIC PRINCIPLE

This is the principle on which the Yarway IMPULSE trap design is based—that variations in temperature of water discharging through two orifices in series cause variations in pressure in an intermediate chamber between the orifices, and that these changes in pressure may be utilized to open and close the trap valve.

ONE MOVING PART

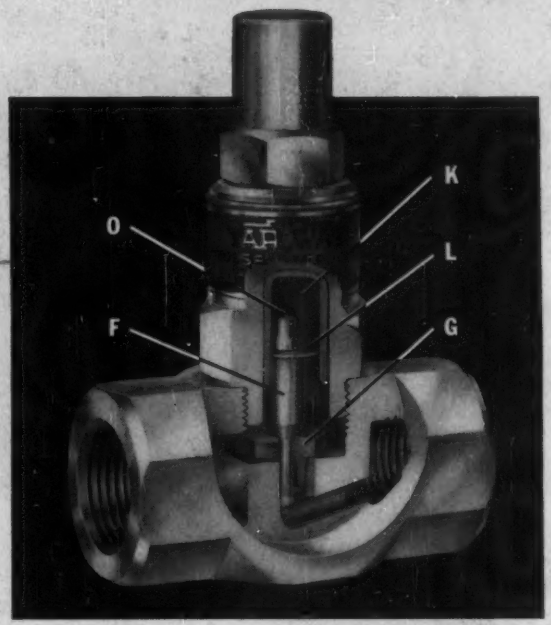
There is only one moving part in a Yarway IMPULSE trap—a small, stainless steel valve. If needed, the entire valve assembly can be replaced in 5 or 6 minutes. It is the simplest of all steam traps to service.

EQUIPMENT HOTTER, SOONER— STAYS HOT

At "start up" the little valve opens wide to discharge air and condensate continuously. This brings equipment into production in the quickest possible time. The valve then actually floats on the condensate load, opening at intervals to discharge each bit of condensate as it forms, maintaining highest, steady temperatures.

HOW IT WORKS

When steam is turned on, condensate and air flow into trap, exerting pressure on underside of control disc L, raising valve F and allowing full discharge through valve seat G.



Meantime, tiny portion of condensate flows around control disc L into control chamber K and discharges through orifice O in the center of valve. This keeps pressure low in chamber K until condensate approaches steam temperature. Some of this hot condensate now begins to flash in control chamber and on downstream side of control orifice O. This chokes the flow through orifice O and pressure builds up in chamber K, snapping valve F shut.

When condensate cools slightly, flashing stops, relieving pressure in K and permitting valve to re-open. In practice, valve opens and closes at short intervals on ordinary condensate loads, remains wide open on heaviest condensate loads. Steam equipment is always kept at its peak operating temperature.

PLUS ADVANTAGES

Other advantages like the following have wide appeal to hundreds of thousands of users:

- Small size and light weight
- Easy, low cost installation
- Minimum maintenance
- Non-freezing
- Stainless steel construction
- No adjustment of valve or seat needed for any pressure
- Low initial cost

started trapping...

A YARWAY IMPULSE STEAM TRAP TO MEET EACH TRAPPING REQUIREMENT

Research and development in the Yarway Steam Laboratory, combined with intensive field testing, have produced a line of steam traps—*all* of the Yarway IMPULSE type . . . to specifically and efficiently meet each of the following classes of trapping service:

Normal requirements for pressures up to 600 psi are satisfied by Yarway Series 60 and 120 IMPULSE Traps in six sizes, ½" to 2".

Light loads for pressures up to 600 psi are handled most efficiently by the ½" Yarway No. 20-A and No. 120-A IMPULSE Traps.

Heavy loads for pressures to 600 psi call for the extra high capacity Series 40 Yarway IMPULSE Trap, available in five sizes, ½" to 2½".

Highest pressure and marine requirements up to 2500 psi are met by the Yarway Integral-Strainer IMPULSE Trap, in six sizes, ½" to 2", flanged, screwed and socket weld types.

NATIONALLY STOCKED, SOLD AND SERVICED

Over 270 Industrial Distributors, conveniently located in every industrial area, stock and sell Yarway IMPULSE Steam Traps . . . and over 35 Yarway field engineers throughout the country are available to help you select the right steam trap for the service and insure maximum efficiency on the job.

For free copy of new bulletin "*The Why and How of Steam Trapping*," write:

YARNALL-WARING COMPANY
128 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY *impulse*®

...a good way to specify steam traps

Series 60 and 120 for normal requirements.

½" No. 20-A and No. 120-A for very light loads.

Series 40 for very heavy loads.

Integral Strainer Impulse Traps for highest pressures and marine use.

Valves for the Petroleum Industry

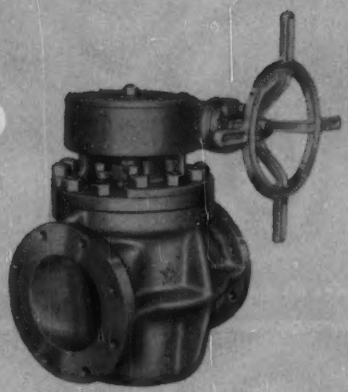


Fig. 3059G—300-Pound Steel Lubricated Plug Valve. Bolted gland type, gear operated. Sizes 6" to 12".

Fig. 2467—Small 300-Pound Stainless Steel O.S. & Y. Gate Valve.

Fig. 6061—600-Pound Steel Swing Check Valve.

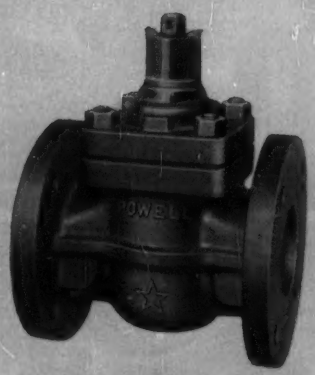


Fig. 2201—175-Pound W.O.G. Semi-Steel Lubricated Plug Valve. Single gland type.

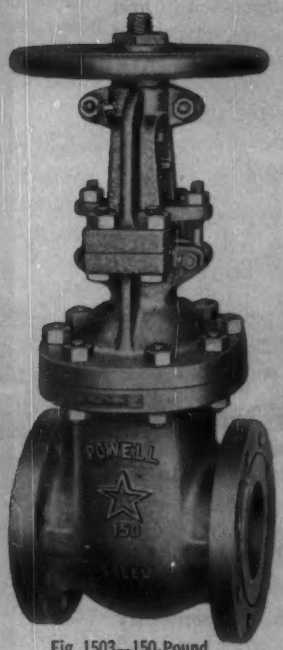


Fig. 1503—150-Pound Steel O.S.&Y. Gate Valve.

Fig. 375—Bronze Gate Valve for 200 pound W.S.P. Union bonnet, inside screw rising stem.

POWELL...

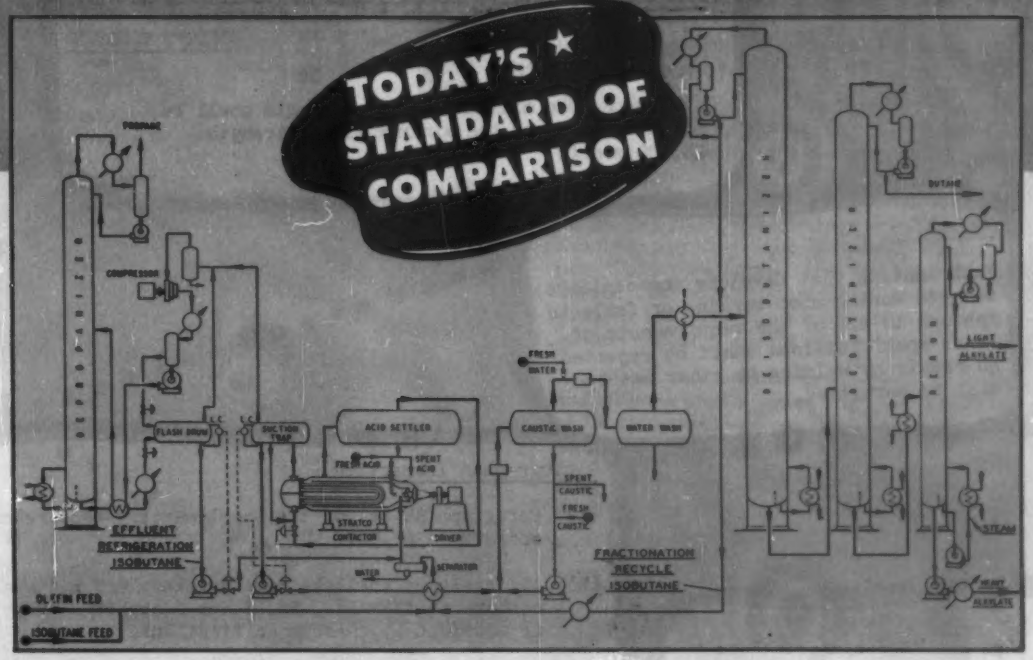
world's largest family of valves

FOR EVERY FLOW CONTROL PROBLEM Powell offers more kinds or types of valves, available in the largest variety of metals and alloys, to handle every flow control requirement. Your local valve distributor will be glad to tell you all about them. Or write to us for the full facts.

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

STRATCO

SULFURIC ACID ALKYLATION



With an Amazing 5 Year Installed Capacity Record

Evidence of the advantages of Stratco H_2SO_4 alkylation is in the table at the right, graphically depicting the position of Stratford Engineering Corporation in the alkylation field. This record, and it is a record for the industry, is the result of proven superiority in yield and quality of product, economy of acid consumption, initial investment and operating costs.

The Stratco Effluent Refrigeration Process is the most efficient process available for producing alkylate and may be used to process propylene, butylene or amylene, either separately or as combined streams.

Electronic Computation, Too

Just send us your data for electronically computed process flow diagrams and complete overall heat and material balances best suited to your operation... ordinarily available within 48 hours.

Representatives

D. D. Foster Co., Pittsburg • Lester Oberholtz, Los Angeles
Rawson & Co., Houston, Baton Rouge • F. J. McConnell Co., N.Y.

Stratco Effluent Refrigeration licensed by Stratford Engineering Corporation. We cooperate with your contractor in plant design.

Stratco H_2SO_4 Alkylation Units
July 1, 1952 .... July 1, 1957

Location	Approx. Design Cap. BPSD	Units
Texas City, Texas	7500	5**
Watson, Calif.	3000	2*
Amarillo, Texas	950	1
Eagle Point, N. J.	2100	2
Lawrenceville, Ill.	2100	2
Puerto Rico	1400	1
Houston, Texas	6300	4
Hattiesburg, Miss.	2650	2
Toledo, Ohio	1500	1
Beaumont, Texas	7900	5
Sugar Creek, Mo.	3900	2
Kent, England	2500	2
Trenton, Mich.	3600	2
Toledo, Ohio	1500	1
Atreco, Texas	2100	2
Anacortes, Wash.	2400	2
Anacortes, Wash.	2100	2
Formosa	900	1

**Closed cycle refrigerated revamp of a 5000 BPSD auto-refrigerated installation.

*Closed cycle refrigerated. All others Stratco effluent refrigerated.

This list does not include 139 units furnished for alkylation service prior to effluent refrigeration development.

STRATFORD ENGINEERING
Corporation
612 West 47th St. PETROLEUM REFINING ENGINEERS Kansas City 12, Mo.

rigid specifications

Tension tests are required to be made at room temperatures and at 670° F. The following minimum physical properties shall be met:

At Room Temperature:

TS	YS	EL	RA	CHARPY V-NOTCH
70,000	30,000	45	50	50

At 670° F. the minimum tensile strength shall be 51,000 p.s.i. and the minimum yield strength 18,300 p.s.i.

Rejection

Each casting that develops unacceptable defects during shop working or fails to conform to all of the requirements of these specifications shall be rejected. No repair by welding or other means will be permitted.

Radiographic Inspection

(a) Paragraph S5 (a) of the Supplementary requirements of ASTM-A 362-52T.

(b) All castings shall be radiographed 100% and shall conform to ASTM-E7 1-52, Class 2 quality, except as modified by these specifications.

(c) The manufacturer shall establish a positive system of identification of the X-ray plates which shall be subject to approval by the inspector. This system shall guarantee complete coverage by radiographing and provide for positive identification between the plate and the subject.

All cast pipe shall be hydrostatically tested to 5,900 p.s.i. and held at that pressure for 20 minutes with zero pipe leakage. Each length of pipe shall be hydrostatically tested at the manufacturer's plant.

Inspection of Penetrants

All castings shall be subjected to inspection by fluorescent penetrants or penetrating dyes both inside and out. All cracks, porosity, or flaws revealed as a result of the Dye Penetrant Test shall be due cause for rejection of the casting.

The 304L stainless steel shall conform to the following ladle analysis:

Carbon	.03 max.		
Manganese	1.50% max.		
Phosphorous	.03% max.		
Sulphur	.03% max.		
Silicon	2.00% max.		
Chromium	18.00	-	21.00%
Nickel	8.00	-	11.00%

Pipe: All pipe of the following sizes shall be centrifugally cast stainless steel as per ASTM-A 362-52T, except as modified by these specifications:

16" - Sch. #160
12" - Sch. #160
10" - Sch. #160
8" - Sch. #140

All pipe shall be machine finished to 125 micro-inch interior and exterior.

for nuclear power

met by U.S. PIPE patented process

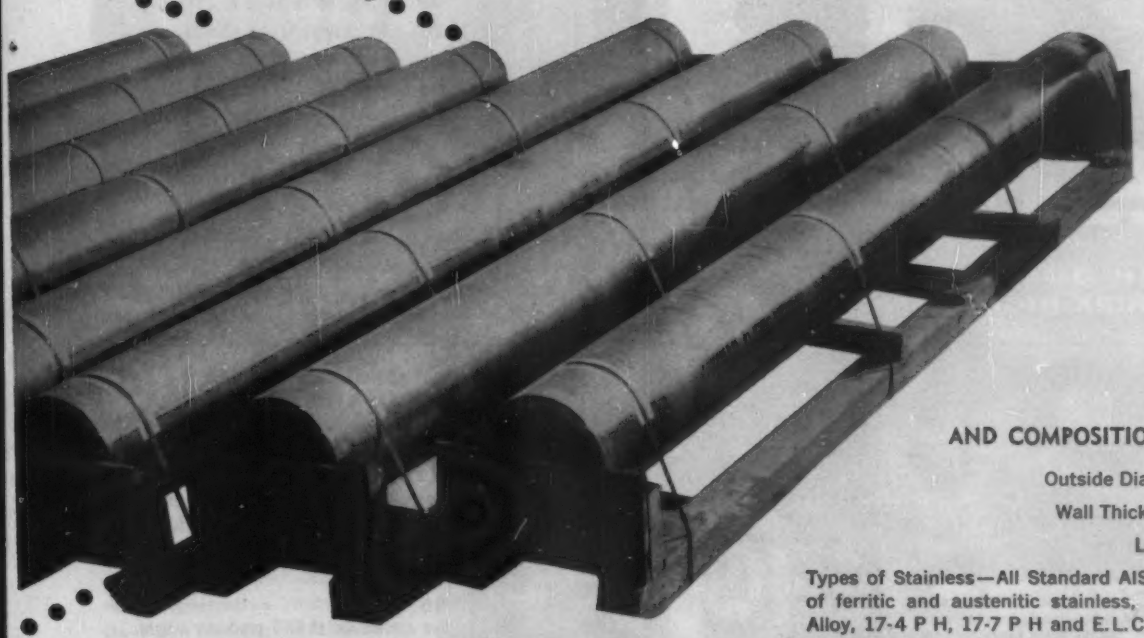
Centrifugally Cast Stainless Steel Solves Many Piping Problems

Combinations of temperatures, pressures and corrosive conditions never encountered before: these are among the piping problems that must be overcome by the men who design the nation's nuclear power installations.

Stainless steel centrifugally cast pipe provides many of the answers. Study the specifications at the left . . . specifications demanded of stainless steel pipe on a recent job for Paul Hardeman, Inc., Los Angeles, California. This pipe is being used for heavy duty, high pressure, elevated temperature service in the primary piping system of the SPERT-III Reactor at the U.S. Atomic Energy Commission's National Reactor Testing Station near Idaho Falls, Idaho. The Stearns-Roger Mfg. Company, Denver, Colorado, is the architect-engineer on this project. A complete tabulation of the actual test data obtained on this pipe and to this specification is available upon request.

U.S. Pipe is headquarters for metal mold centrifugally cast alloy and stainless steel pressure pipe over a wide range of special and standard analyses—in large and small quantities—and to individual specifications.

If piping of the type described above is the bottleneck in your nuclear power planning, write and outline the problem.



SIZE RANGE AND COMPOSITION FLEXIBILITY

Outside Diameter—6" to 50"

Wall Thickness—¾" and up

Length—Up to 16'

Types of Stainless—All Standard AISI and ACI grades of ferritic and austenitic stainless, including No. 20 Alloy, 17-4 P H, 17-7 P H and E.L.C. grades.

UNITED STATES PIPE & FOUNDRY CO.

Steel and Tubes Division

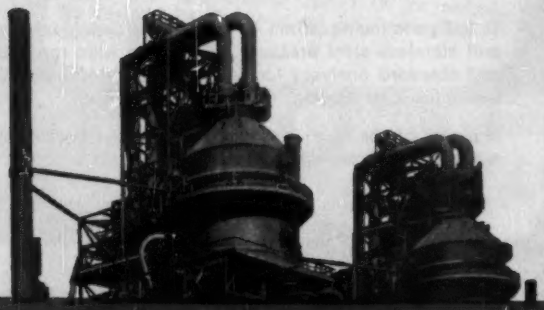
STEEL & TUBES U.S. PIPE DIVISION

BURLINGTON, NEW JERSEY

SALES OFFICES: LOS ANGELES, SAN FRANCISCO, CHICAGO, ST. LOUIS, COLUMBUS, PITTSBURGH, HARTFORD, BURLINGTON

There is a specific A. P. Green Castable for every refractory application in the Petroleum Field. Methods of installation, including troweling, pouring, and "gun" application vary with the particular characteristics of the job. Each A. P. Green castable refractory is specifically designed to provide the required properties of insulation, strength, abrasion resistance and refractoriness for high efficiency operation.

For detailed information and recommendations write the Engineering Department of the A. P. Green Fire Brick Company . . . or call your local A. P. Green distributor.



KAST-SET

A. P. Green KAST-SET is a rapid setting, high strength refractory castable. Mixed with water, it takes on a hydraulic bond without the application of heat. KAST-SET will not shrink, has excellent resistance to abrasion, and is ideally suited for monolithic linings. It may be used at temperatures up to 2700°F.

KAST-O-LITE

A lightweight, insulating castable refractory recommended for temperatures up to 2500°F. It is used for complete monolithic linings in all types of oil stills and heaters, tar stills, air heaters, heat treating furnaces, flues and stacks, and for furnace hearth insulation.

CASTABLE INSULATION NO. 20

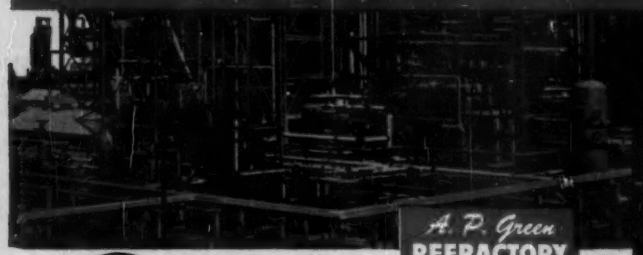
A hydraulic-setting castable for temperatures up to 2000°F. Recommended for complete monolithic linings and lightweight panel construction in oil stills and heaters.

CASTABLE BLOCK MIX

A hydraulic-setting castable insulation for temperatures up to 1600°F. CASTABLE BLOCK MIX combines the advantages of a castable material with low conductivity and light weight.

A.P. GREEN

HIGH QUALITY REFRACTORY AND INSULATING CASTABLES ASSURE HIGH EFFICIENCY OPERATION OF PETROLEUM EQUIPMENT



Esso Standard Oil Company's fluid catalytic cracking units at the Baton Rouge Refinery where A. P. Green products are in use.

A. P. Green REFRACTORY PRODUCTS

CASTABLES FOR GUN APPLICATION

SK-7 and KS-4
were designed for use in combination to form composite linings in catalytic regenerators, reactors, and other petroleum equipment. Frequently a lining utilizing only SK-7 or KS-4 will fulfill the requirements of the job.

SK-7

Gun application of SK-7 produces a lightweight lining with excellent strength and insulating efficiency. Ideal lining for ducts, flues and breechings.

KS-4

This strong abrasion resistant castable can be gun applied with a minimum of rebound loss. Recommended for catalytic regenerator linings, stack linings, bubble towers, and duct linings exposed to abrasion or corrosion.

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.

PLANTS:
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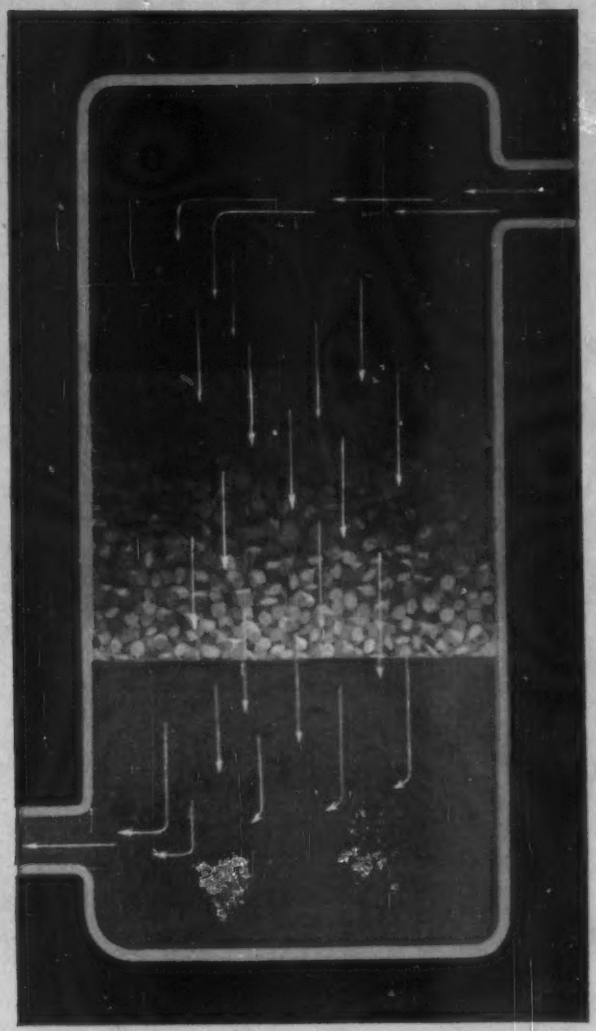


New AERO* HDS-2 Catalyst

Unequaled for Efficient Economical Upgrading of Feedstock

AERO HDS-2, Cyanamid's *new* cobalt-molybdena hydrodesulfurization catalyst meets all the requirements of modern hydrogen treating. Its superior characteristics are evidenced by the improved performance it provides in efficient and profitable upgrading of refinery streams.

Because of the low bulk density and high volume activity of AERO HDS-2, you can maintain throughput rates with 30% less catalyst—or you can increase throughput on the same quantity of catalyst, while operating at a specified treating level. Add, too, the excellent efficiency of HDS-2 in sulfur and nitrogen removal.

Pound for pound, AERO HDS-2 outperforms all other hydrodesulfurization catalysts and is undoubtedly best for *your* process. Your Cyanamid representative will be glad to furnish details. Call or write him today.

*Trademark

HIGHLY SELECTIVE PLATINUM CATALYSTS

For normal or HDS-upgraded feedstocks, AEROFORM® Platinum Reforming Catalysts provide excellent performance in octane improvement. Good stability and easy regeneration contribute to their low cost-per-barrel.

TOP ANTI-WEAR FOR TOP LUBES

Where *extra* protection is required for engine break-in, AEROLUBE® 93-C concentrated zinc dithiophosphate does the job. Excellent oxidation inhibition and anti-wear properties make it ideal for both initial fill and regular use in premium oils.

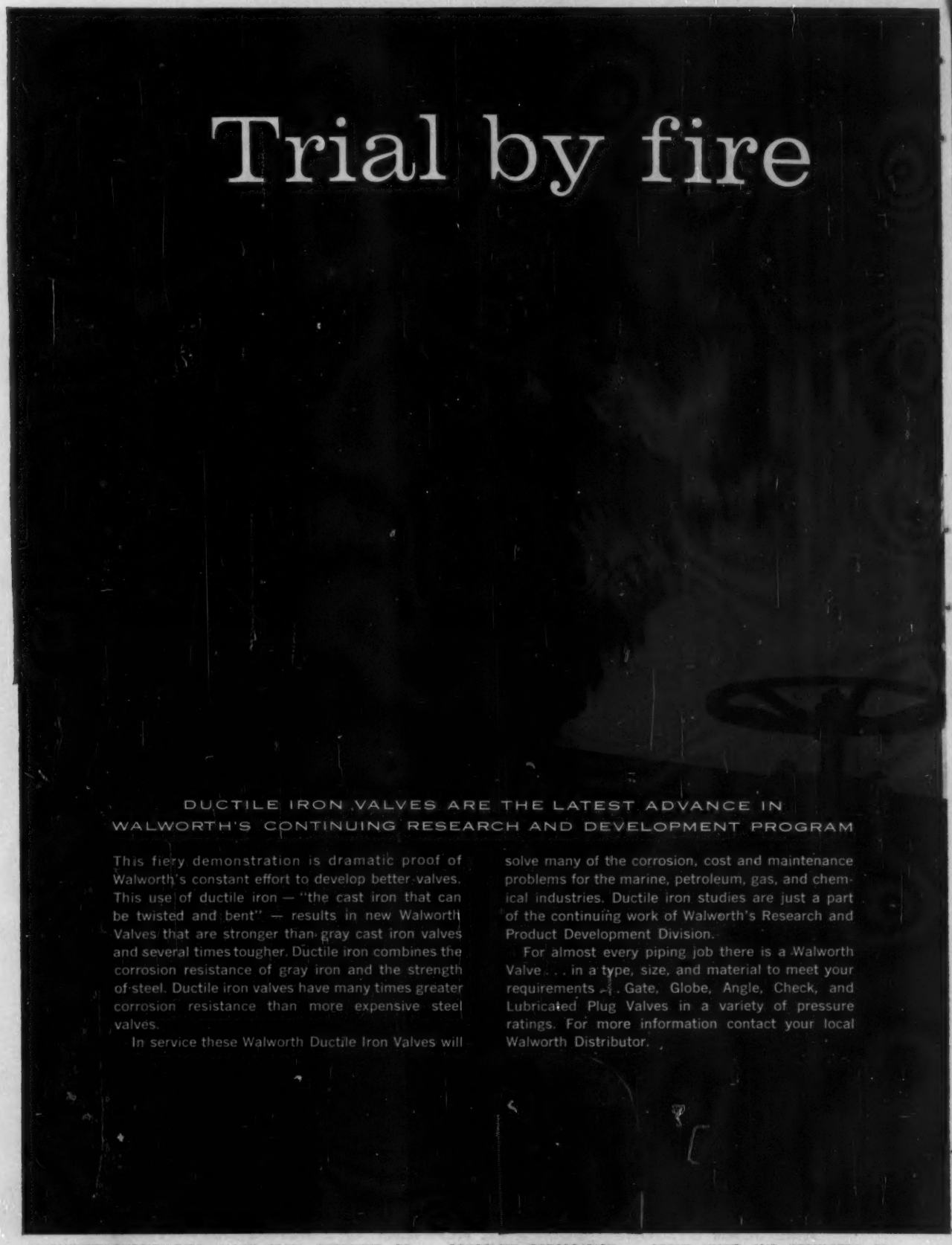
The invaluable experience and advice of operating oil men is sought by Cyanamid's field men — is fed into our thoroughly modern laboratories — and results in superior, highly effective Cyanamid products. That is why each is so well suited for its recommended application.

CYANAMID

AMERICAN CYANAMID COMPANY, REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y. • In Canada: North American Cyanamid Limited, Toronto and Montreal

For more data on advertised products, use Readers' Service Cards, last page.

Trial by fire



DUCTILE IRON VALVES ARE THE LATEST ADVANCE IN WALWORTH'S CONTINUING RESEARCH AND DEVELOPMENT PROGRAM

This fiery demonstration is dramatic proof of Walworth's constant effort to develop better valves. This use of ductile iron — "the cast iron that can be twisted and bent" — results in new Walworth Valves that are stronger than gray cast iron valves and several times tougher. Ductile iron combines the corrosion resistance of gray iron and the strength of steel. Ductile iron valves have many times greater corrosion resistance than more expensive steel valves.

In service these Walworth Ductile Iron Valves will solve many of the corrosion, cost and maintenance problems for the marine, petroleum, gas, and chemical industries. Ductile iron studies are just a part of the continuing work of Walworth's Research and Product Development Division.

For almost every piping job there is a Walworth Valve . . . in a type, size, and material to meet your requirements . . . Gate, Globe, Angle, Check, and Lubricated Plug Valves in a variety of pressure ratings. For more information contact your local Walworth Distributor.

WALWORTH SUBSIDIARIES: **ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO.**

In the first stage of thermal shock test, oil fire and gas flame heat a 6-inch Walworth Gate Valve constructed of ductile iron to a red hot temperature of 1350°F.

Now the Walworth Valve is quickly chilled with streams of water. A cast iron valve could shatter under such a drastic and rapid change in temperature.

Slightly scorched, the valve keeps its shape and dimensions despite the ordeal and is completely operable. The test proved that, under these conditions, Walworth ductile iron valves have a thermal shock resistance equal to that of more expensive steel valves.

NEW WALWORTH PRODUCTS AND DEVELOPMENTS

FORGED STEEL WEDGE GATE VALVES

. . . for water, steam, gas, and air service to 850°F. Oil or oil vapor to 1000°F. OS & Y types. Screwed or socket welding ends. Bolted or union bonnets. Sizes from ¼ to 2 inches.

FABRICATED PULP STOCK VALVES

. . . for lines carrying pulp stock in varying concentrations, slurries, and other fibrous materials in suspension. All-welded stainless steel construction. Corrosion resistant. Sizes from 3 to 30 inches.

PVC VALVES AND FITTINGS

. . . made of rigid, unplasticized polyvinyl chloride. Highly resistant to chemical attack. Non-toxic. Non-aging. Extremely low flammability. Sizes from ½ to 4 inches.

WALWORTH

60 EAST 42nd STREET, NEW YORK 17, N. Y.

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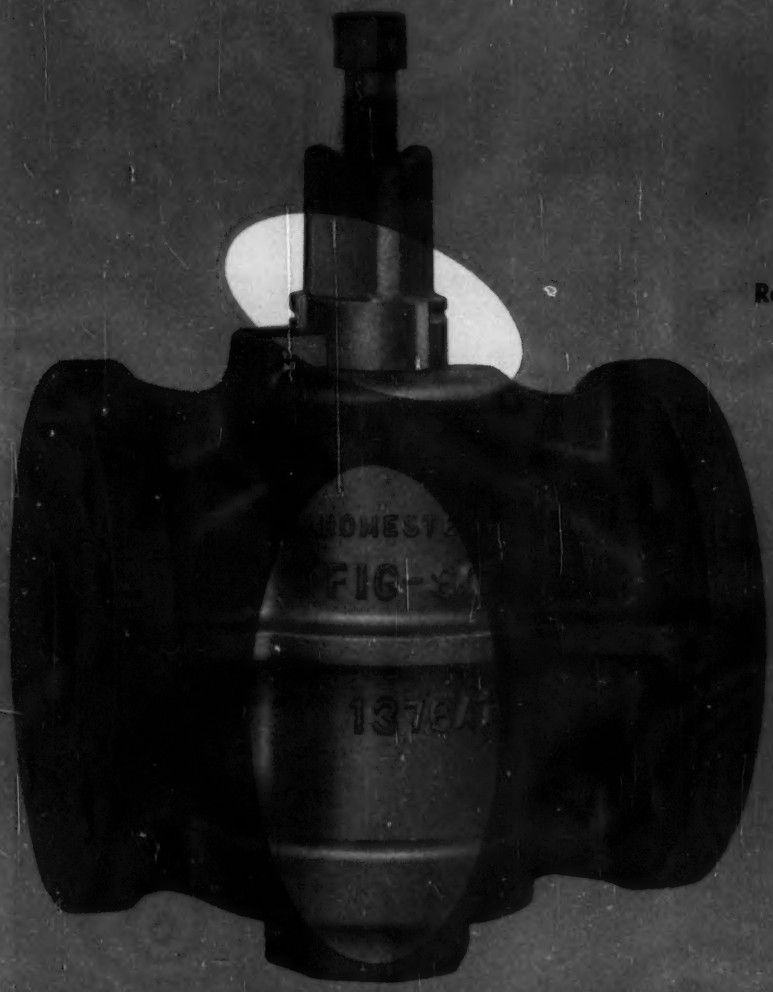
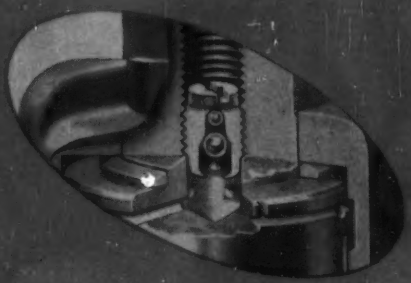
SOUTHWEST FABRICATING & WELDING CO., INC. • M&H VALVE AND FITTINGS CO. • WALWORTH COMPANY OF CANADA, LTD.

In the spots that count... Homestead Valves are

LEAKPROOF





Reinforced Teflon and lubricant seal

Controlled pressurized lubricant seal

Lower cost per year valve service is guaranteed by Homestead Lubricated Plug Valves. These are the features that make them leakproof and extend their useful life . . . reinforced Teflon* head seal, double ball and lubricant sealed check valve, and their exclusive controlled pressurized lubricant seal.

Homestead's controlled lubricating system forces a chemical film over all sealing surfaces at more than 300 pounds pressure. In addition, it prevents sticking, by its piston-like movement of the plug during each lubrication. See how Homestead fills your valve needs. Write today for Reference Book 39, (Section 5), for complete information on Homestead Lubricated Plug Valves.

**DuPont registered trademark.*

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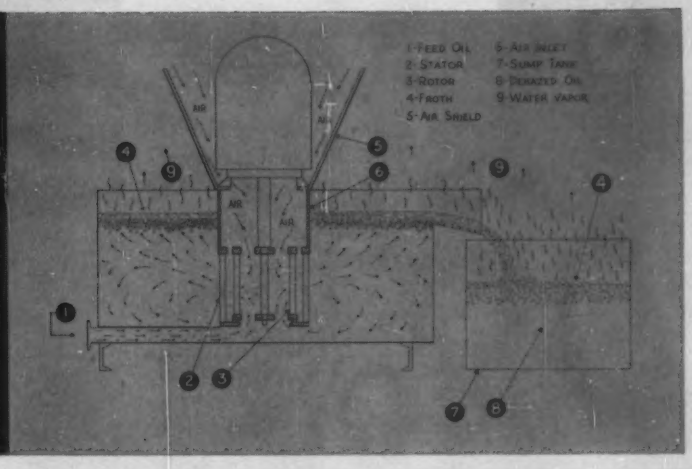
v

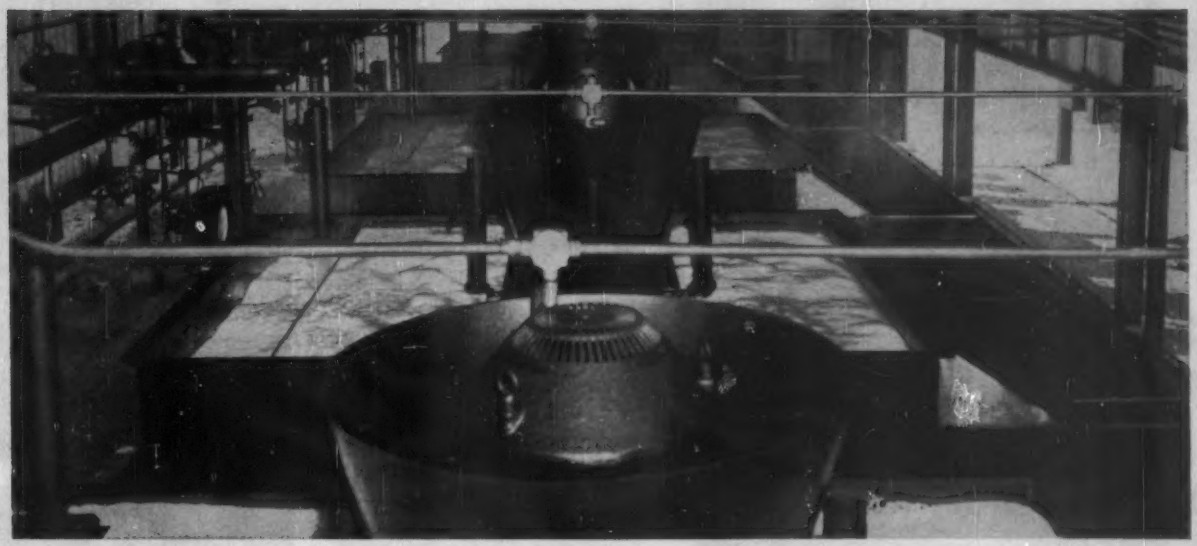
HOMESTEAD VALVE MANUFACTURING COMPANY

P. O. Box 45 • Coraopolis, Pa.

HENDRICK HYDRO-DEHAZER



removes haze from refinery oils in a hurry!



Here's a process that has been operating with a great deal of economy in several major refineries: The Hydro Dehazer's huge rotor mixes moisture-laden oil with free air until the moisture is absorbed by the air and discharged to atmosphere. The entire cycle achieves optimum efficiency without the use of compressed air, high heat, chemicals or other additives. Capacities range to 450 bph for No. 2 fuel oil at an inlet temperature of 130° F. with a haze point of 70° depending on the consistency of the charge. For details or a pilot model demonstration mail coupon today!

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MANUFACTURING COMPANY
36 Dundaff Street, Carbondale, Pennsylvania
Sales Offices in Principal Cities

Perforated Metal • Perforated Metal Screens • Wedge Slot and Wedge Wire • Architectural Grilles
Mikro Open Steel Flooring • Shur-Site Treads • Armagrids • Hendrick Hydro Dehazer

HENDRICK MANUFACTURING COMPANY
36 Dundaff Street, Carbondale, Pennsylvania

Gentlemen:

I am interested in learning more about the new Hendrick Hydro Dehazer.

☐ Please send technical data.

☐ Please arrange demonstration of the Dehazer Pilot Model.

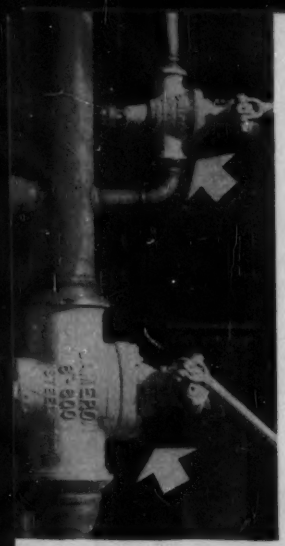
Name_____ Title_____

Company_____

Street_____

City_____ Zone_____ State_____

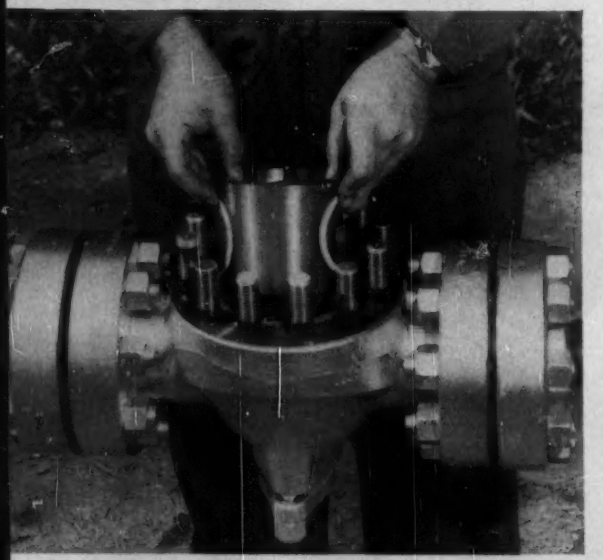
For more data on advertised products, use Readers' Service Cards, last page.



SMOOTH DESIGN

The sealing surfaces of Cameron Non-Lubricated Lift-Plug Valves are smooth—so smooth they require no greases, no expensive lubrication program to maintain a perfect seal. They close bubble-tight on today's elusive, high pressure fluids and gases.

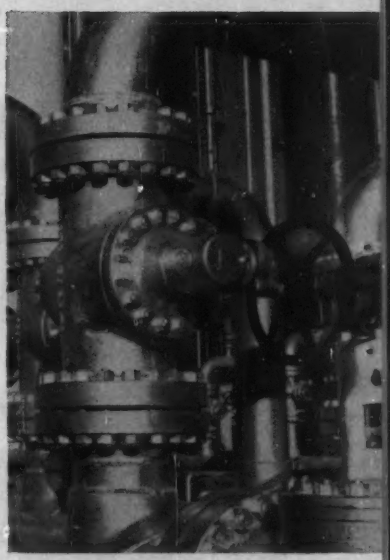
The unusual Cameron Lift-Plug design eliminates friction because the plug is lifted from the seat before rotating—actually never touches the seat except when completely open or closed. Unlike ordinary valves, Lift-Plugs employ a removable seat which is sealed off from the body and will not reflect pressure distortions. As an added benefit, this makes possible special trims for a wide range of services and temperatures — stainless steel for corrosives, Hycar for LPG, etc.

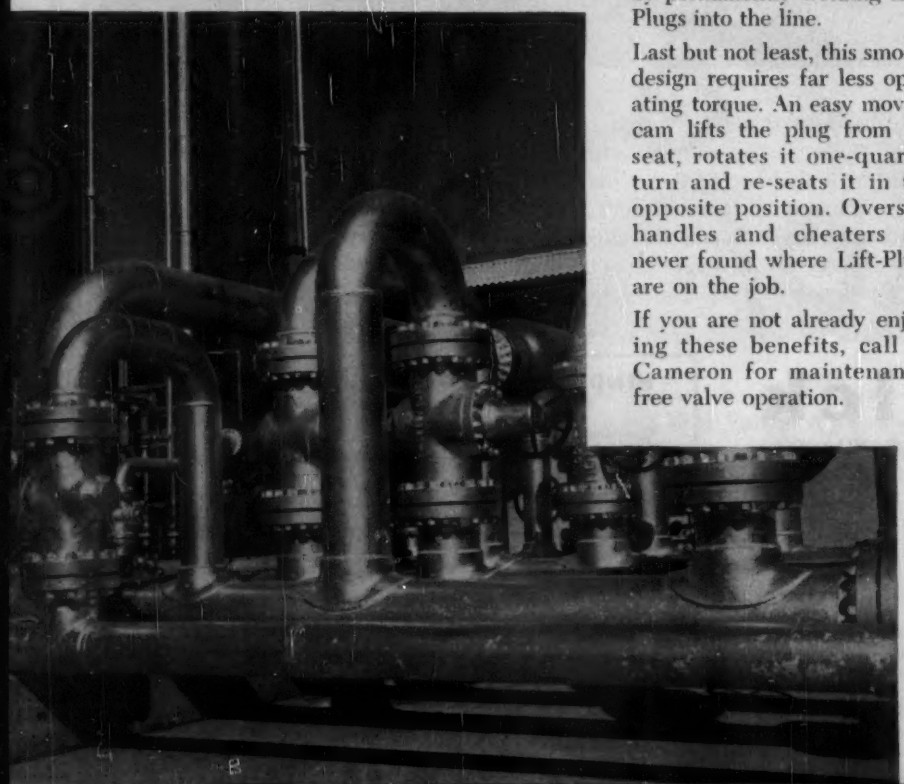


When repairs are finally necessary the seat and plug may be easily replaced without removing the valve from the line. Flanges and connection leaks can be eliminated by permanently welding Lift-Plugs into the line.

Last but not least, this smooth design requires far less operating torque. An easy moving cam lifts the plug from the seat, rotates it one-quarter turn and re-seats it in the opposite position. Oversize handles and cheaters are never found where Lift-Plugs are on the job.

If you are not already enjoying these benefits, call on Cameron for maintenance-free valve operation.





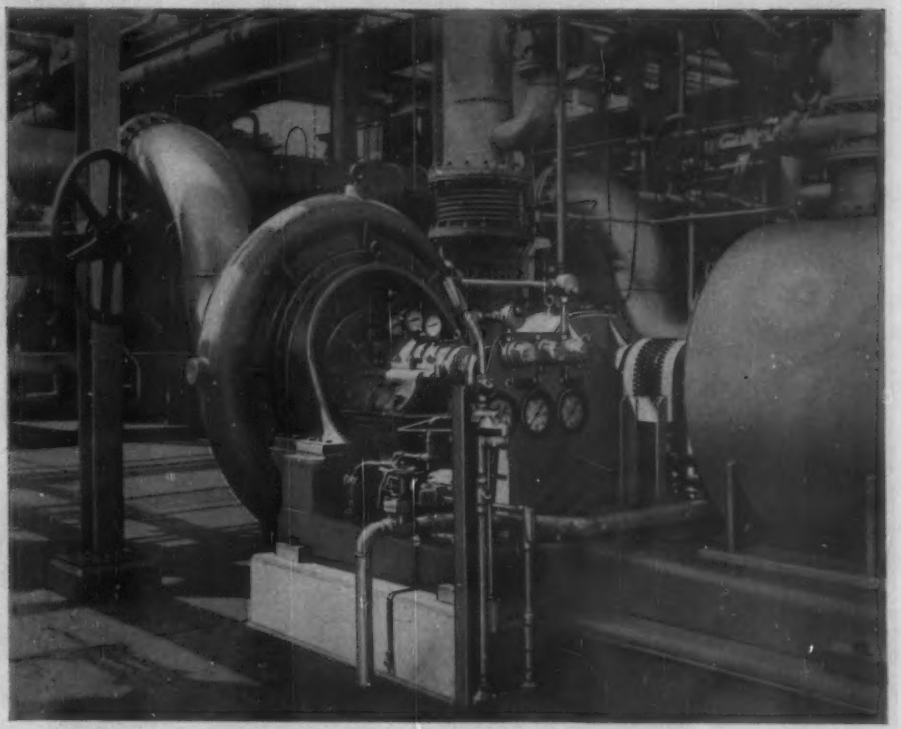
Cameron

IRON WORKS, Inc.

P. O. Box 1212 — Houston, Texas

Export Office: 7912 Empire State Bldg., New York City. In England: Cameron Iron Works, Ltd., Time & Life Bldg., New Bond Street, London W. 1 England

FOR TIDEWATER OIL COMPANY'S GREAT NEW REFINERY



Process Design
—Ralph M. Parsons Co.

Constructors
—C. F. Braun & Co.

R-C
Centrifugal Equipment purchased for this installation

Three single-stage centrifugal blowers, two turbine driven and one motor driven. Each blower is rated at 11,500 cfm at 4.8 psig operating at 5100 RPM requiring approx. 320 HP

R-C Centrifugal Blowers Supply Combustion Air for Sulfur Plant

For the industry's largest sulfur-recovery plant at Tidewater's "refinery of the future" at Delaware City, Roots-Connersville centrifugal blowers supply combustion air for processing hydrogen sulfide from sour crudes to elemental sulfur.

One of the basic design requirements for this plant is extreme flexibility. When the refinery is operating on high-sulfur crudes, sulfur production may reach 340 long tons per day. With low-sulfur crudes, production may be less than one-fifth this amount.

To satisfy these widely varying requirements, Roots-Connersville centrifugal blowers assure positive control of air delivered to the reaction furnaces. Whatever the conditions may be, they provide the kind of dependability that results in continuous, efficient operation for long periods of time. Whatever the service, you can count on this dependability in Roots-Connersville centrifugal equipment in capacities from 1,100 to over 100,000 cfm.

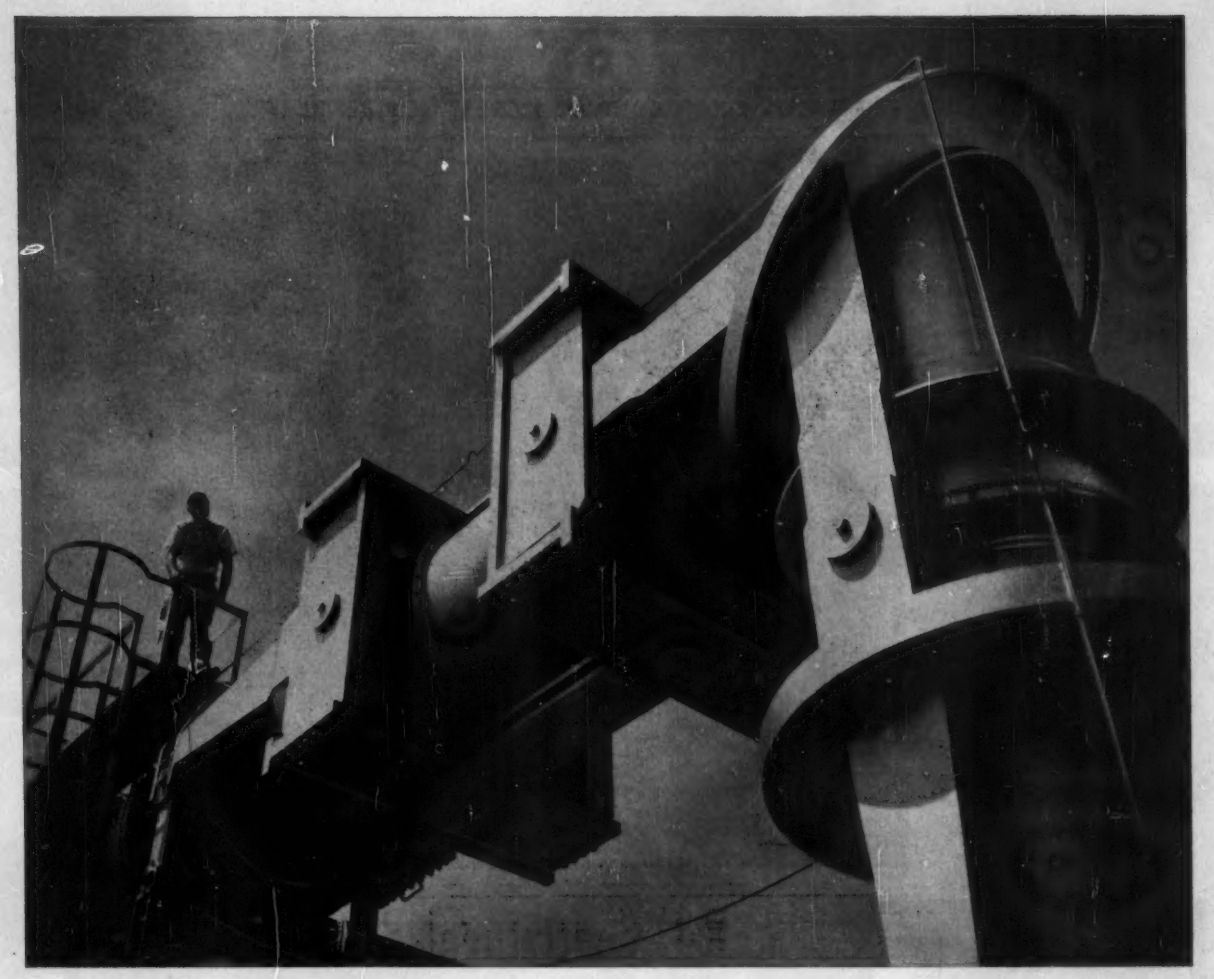
For additional data, please refer to our section in Chemical Engineering Catalog or Mechanical Catalog or write for Bulletin 120-B-14.

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.

158 Crescent Avenue, Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto, Ont.

For more data on advertised products, use Readers' Service Cards, last page.



MACH 5...

with the help of

ADSCO CORRUFLEX EXPANSION JOINTS

ADSCO DIVISION
20 MILBURN STREET
BUFFALO 12, NEW YORK

YUBA

YUBA CONSOLIDATED INDUSTRIES, INC.

Wind rushing through a wind tunnel at the Arnold Engineering Development Center, Tullahoma, Tenn., reaches a speed of five times the speed of sound. That is 3800 miles an hour. Under this condition, this Air Force Research and Development Command Center can test aircraft, missiles and projectiles under simulated characteristics of high-speed flight.

But the air-supply ducting grows and twists under the high temperatures and pressures of the air rushing inside. Something must absorb this movement occurring in three directions, or the ducting would buckle. Easily and efficiently, the movement is absorbed by a combination of Adsco Corruflex Hinge and Universal Expansion Joints, shown above in a section of the ducting.

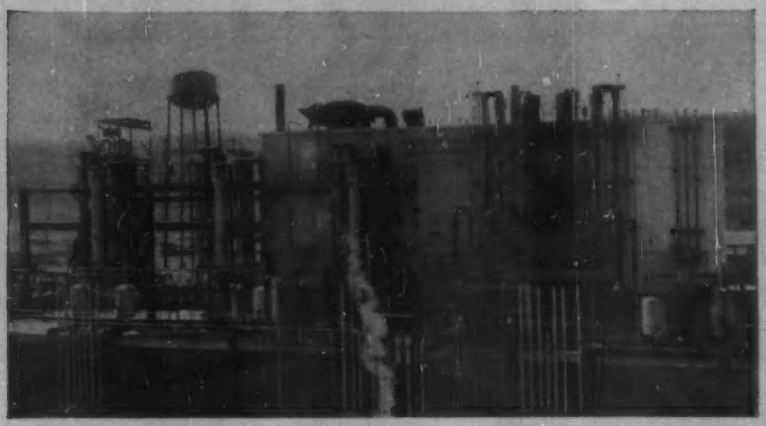
The design and development of these expansion joints to customer's specialized requirements is only one of the many engineering feats performed by Adsco in recent years. Consult Adsco the next time you need help on piping engineering.

For more data on advertised products, use Readers' Service Cards, last page.

News from
National Carbon Company
Division of Union Carbide Corporation · 30 East 42nd Street, New York 17, N. Y.
Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. IN CANADA: Union Carbide Canada Limited, Toronto

"KARBATE" IMPERVIOUS GRAPHITE SHELL AND TUBE HEAT EXCHANGERS PROVE THEIR ECONOMY IN COOLING CORROSIVE GASES

Gas coolers of "Karbate" Impervious Graphite cost less and last longer than coolers made of less corrosion-resistant materials.



Ten "Karbate" Impervious Graphite Shell And Tube Heat Exchangers cooling and condensing mixtures of organic vapors and hydrogen chloride. Units are arranged in pairs—uninsulated unit in each pair has plant cooling water on shell side; insulated unit is refrigerated.

These standard "Karbate" heat exchangers have 685-⅞" I. D. "Karbate" tubes assembled between "Karbate" tube sheets in 45" diameter steel shells. Corrosive water-saturated sulfur dioxide gas, which contains considerable entrained sulfuric acid, will enter and leave tube sides through 24" diameter connections on "Haveg" phenolic resin covers.

National Carbon provides complete Technical Service—An experienced technical staff designs and rates "Karbate" Shell and Tube Heat Exchangers manufactured and guaranteed by National Carbon. Dr. D. Q. Kern, well-known consultant and author of PROCESS HEAT TRANSFER, serves as an advisor to this group.

Particularly significant today is the economical cooling of corrosive gases. "Karbate" Impervious Graphite Heat Exchangers have the corrosion resistance, high thermal conductivity, immunity to thermal shock, and moderate cost vital to this service.

For cooling corrosive gases, "Karbate" Exchangers operate either horizontally or vertically, usually with the corrosive gas inside the "Karbate" tubes and with the coolant in the steel shell. These exchangers are furnished with shells of "Haveg" phenolic resin, impervious graphite, rubber or glass-lined steel for operation with corrosive gas on the outside of the "Karbate" tubes.

A complete line of "Karbate" Heat Exchangers is available in sixteen shell sizes from 6" I.D. to 45" I.D. with tube lengths of 6', 9', 12', 14', and 16'. Standard components are carried in stock for immediate assembly of units having up to 3585 sq. ft. of heat transfer surface.

For full details, request **Catalog Section S-6800NL**

NATIONAL TRADE-MARK

The terms "National", "N" and Shield Device, "Karbate" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

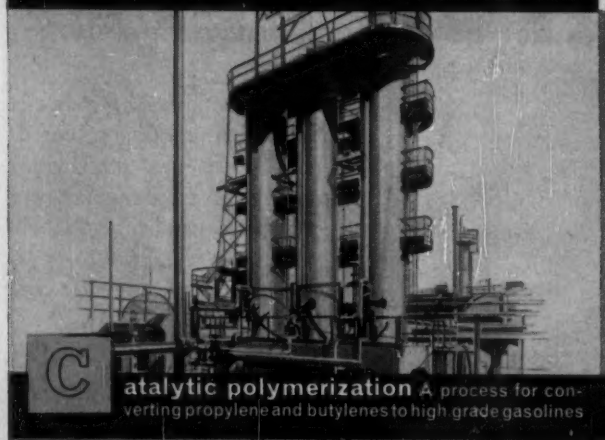
UNION CARBIDE

Somewhere on these pages is a

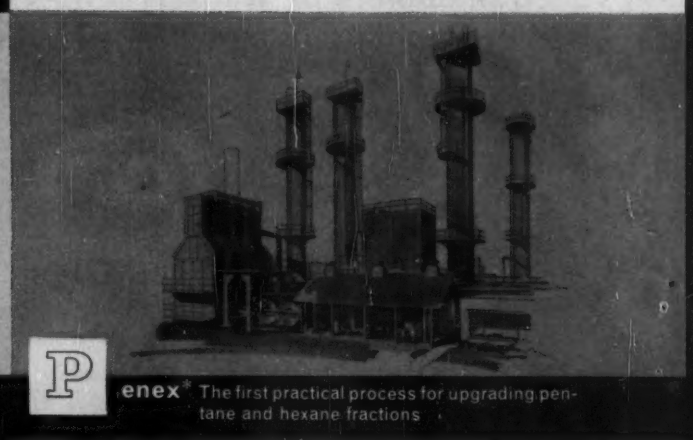
UOP

answer to most every petroleum processing problem.

Working out the solution to a processing problem can be a pretty tough assignment for any refiner. But this is a UOP specialty and it's highly probable that UOP can come up with the right answer. Perhaps, we don't have all the answers right on tap but our more than 40 years of research and engineering development in oil refining technology is pretty good assurance that we can work them out. Quite possibly you will find



Catalytic polymerization A process for converting propylene and butylenes to high grade gasolines

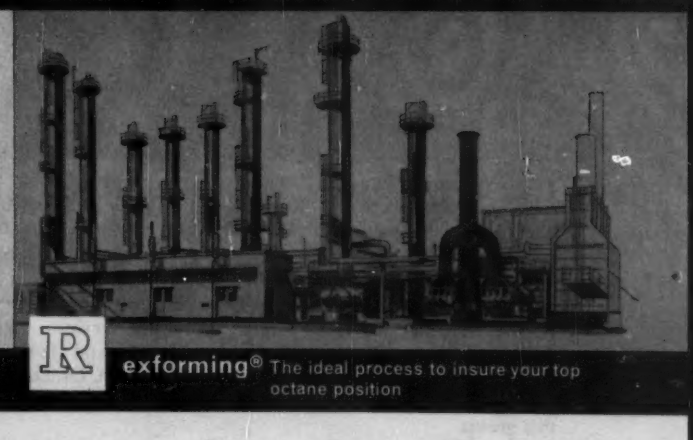


Penex® The first practical process for upgrading pentane and hexane fractions

Fluid catalytic cracking Improved heavy oil conversion process for higher yields and octane numbers

Vacuum distillation and visbreaking Efficient, economical processes for feed preparation

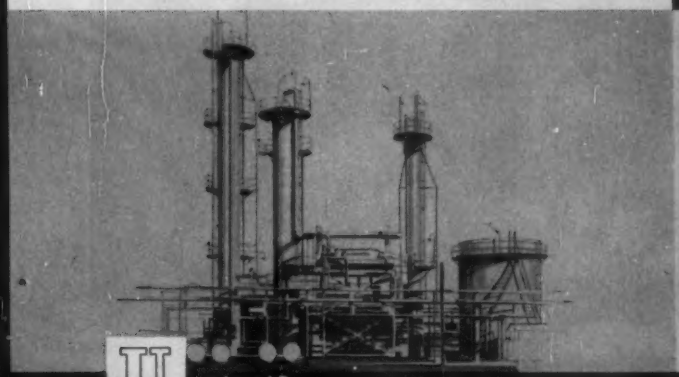
Low pressure coking A process that adds market flexibility



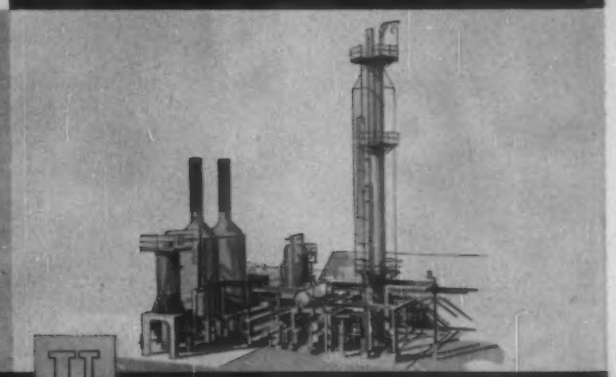
Rexforming® The ideal process to insure your top octane position

the solution among the processes shown here. For these represent only some of the refining and petrochemical processes UOP makes available to all refiners, anywhere. If you would like to know more about all the refining and petrochemical processes available from UOP we'll be glad to send you our handsome new 36 page brochure describing these more fully. Just drop us a line on your company letterhead.

P latforming® The most popular process for upgrading gasolines



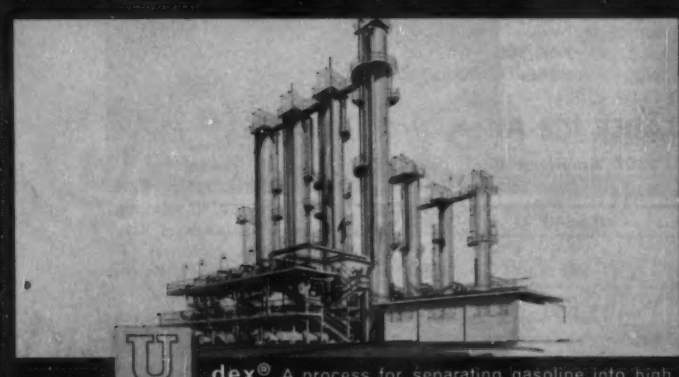
U nisol® A finishing process without octane degradation



U nifining® A modern process for completely purifying petroleum distillates

HF Alkylation A catalytic process for producing alkylate

T hermal cracking An improved design of a basic refining process



U dex® A process for separating gasoline into high and low octane fractions

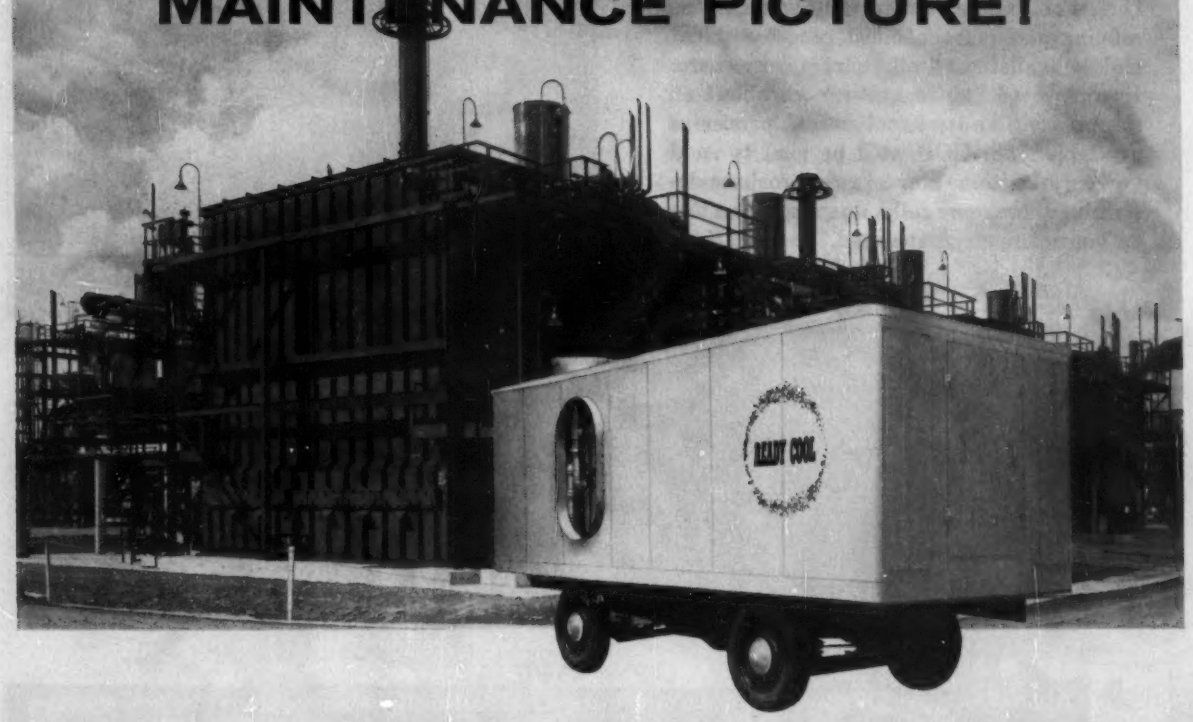
UOP® UNIVERSAL OIL PRODUCTS COMPANY

30 Algonquin Road
Des Plaines, Illinois, U. S. A.

MORE THAN FORTY YEARS OF LEADERSHIP IN PETROLEUM REFINING TECHNOLOGY

*Trademark

PUT READY COOL IN YOUR MAINTENANCE PICTURE!



AIR CONDITIONING FOR M & C? RIDICULOUS!!!

Now stop and think a minute. Couldn't you often use a high velocity of cold air to speed cooling of heated vessels? A 60 Ton* entirely portable READY COOL produces 18,000 CFM of air 25 to 30 degrees below ambient temperature even on the hottest summer days at an operating cost of 26¢ per ton/hour.

RESULTS ARE AMAZING!

CASE I One large petrochemical plant in East Texas was dissatisfied with the 70 hours lost in cooling down their cracking heaters for maintenance and repair, and secured a 50 ton READY COOL. The unit was used as a blower until 600 degrees F. was reached, then the air conditioning was added. There was no brick spalling. The cooling down period was reduced to 12 hours average. Worker efficiency was increased approximately 85% working in 75 degrees instead of 120. ***They reported the heaters were repaired and back on stream in less time previously required for cooling alone.***

CASE II Another Chemical Plant said their cooling down time was reduced from 48 hours to 8½ using a READY COOL.

CASE III A third Plant stated their payroll was reduced an average of 40% in hot areas where they used their 40 Ton model and that, with less down time, ***it paid out each time they used it.***

* $6,900 FOB
New Orleans, La.

READY COOL **PORTABLE ICE AIR CONDITIONERS**

2301 American Bank Building
New Orleans, Louisiana

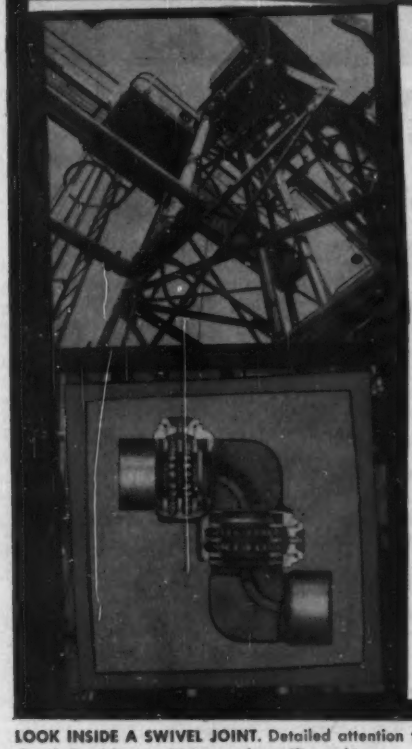
Model	#5820	#5830	#5840	#5850	#5860
Tons of Refrigeration	20	30	40	50	60
C.F.M.	6,000	7,500	12,000	15,000	18,000
BTU Per Hour Capacity	240,000	360,000	480,000	600,000	720,000

All Units Trailer Mounted; Gasoline or Electric Powered

For more data on advertised products, use Readers' Service Cards, last page.

CHIKSAN HELPS UNION OIL CUT OUT THE COKE

Swiveling Chiksan Decoking Arms combine flexibility and stamina to handle 1700 psi hydraulic water force used to remove petroleum coke from coke drums



During refining of crude stock at Union Oil's Oleum refinery, petroleum coke is produced as a valuable by-product. When coke drums become full, they are "decoked" with a high pressure water jet which first drills out a pilot hole, then cuts the coke loose, moving it out of the tower in slurry form. Safety dictates all metal flexible lines. The solution—Chiksan Swivel-Jointed All Steel Decoking Arms. These rugged units provide free turning rotation with all movement carried out in a predetermined arc. Service life of the Chiksan Decoking Arms is measured in years and maintenance involves an occasional packing replacement. If your equipment or plant lines require flexibility, let Chiksan swivel joints provide the answer with less maintenance, limited replacements, and the safety that only steel can provide. Write today for literature and price lists.

LOOK INSIDE A SWIVEL JOINT. Detailed attention to detail. Precision machining and specific packing seals for specific services. These are the quality-plus features built into every Chiksan Swivel Joint.

fmc CHIKSAN

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

CHIKSAN COMPANY—BREA, CALIFORNIA • CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

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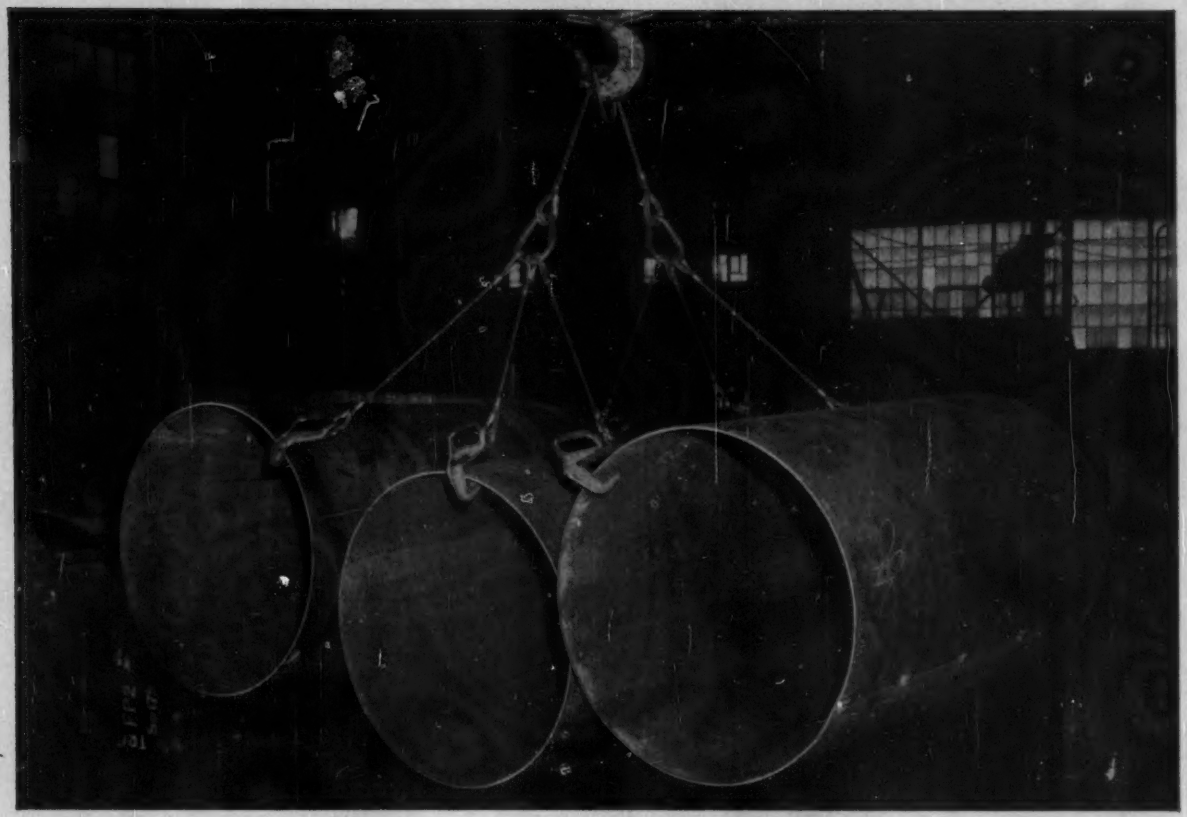
#57-29



Tuffy

Slings and Hoist Lines

now...thanks to Tuffy...three make the trip instead of one

The Toronto Iron Works makes tanks on a production line basis. Plate steel is rolled and welded into 8′-long tank sections at one end of the plant. The sections are picked up by an overhead crane and transported to the far end for final assembly. Formerly they were carried on a chain... a single section per trip, tying up the crane all day.

In the course of a plant survey, which is a valuable part of the service rendered by Tuffy distributors, a better idea came up. Why not make a rigging of Tuffy Slings ...handle all three sections of a tank at the same time... free the crane for other work? That's exactly what is happening in the picture above. Result: easier handling, ⅔ less crane time, big production-dollar savings. Further result, in the words of a company official:

"This was the first time this plant used Tuffy Slings. Now they have standardized on them."

Tuffy Slings are ideal for this job (and countless others) because of their superb combination of super-strength and free-flowing flexibility. It's just about impossible to kink a Tuffy Sling; and if you should, the kinks smooth out with no damage done.

Another Tuffy plus feature: Tuffy's pressed-on ferrule is applied over tuck splices under tremendous pressure to give the sling eye 100% of fabric strength.

Your Tuffy Distributor: a Good Man to Know

He's stocked to meet your needs; ready to make fast delivery of your Tuffy Slings, Tuffy Hoist Lines (famous working partners of Tuffy Slings), and Union Wire Rope. And he's qualified to help you find money-saving ways of using Tuffy products in your operation. Get in touch with him.

FREE! Tuffy Sling Handbook

Gives full data on Tuffy Sling types, uses, dimensions, weights and rated loads. Plus a complete rigger's manual and engineer's handbook on wire rope constructions and specifications. Write for your copy now.

union Wire Rope corp.

Specialists in high carbon wire, wire rope, braided wire fabric, stress relieved wire and strand

2284 Manchester Avenue **Kansas City 26, Mo.**

For more data on advertised products, use Readers' Service Cards, last page.

The Mail Box . . .

Asks Re Problem

To the Editor:

May I ask Dr. Zenz about this problem from Part II "Fluid Catalyst Design Data" (PR 36 No. 5, 1957, page 261):

For two-component mixtures Zenz plots the results of Matheson et al in terms of viscosity over composition of blend (Figure 6.) It can be seen that viscosity of fluid beds has an optimum value for a composition of blend (break-point) that fairly well agrees with the composition by the theoretical considerations of Trawinski. This leads to the conclusion that the structure of blend in Matheson's experiments in fact equals or at least approaches the distribution Trawinski takes as basis for his mathematical model of distribution:

Fine particles surround the coarse ones, there is no segregation of fine and coarse particles. So fine particles reduce the viscosity of a bed of coarse particles.

On the other hand, several authors (for example, Brotz in Chem-Ing Technik 24, No. 2, 1952) observe a segregation in fluidized beds: White beads (3-mm diameter) on the bottom of the vessel and black beads (8-mm diameter) put above them are fluidized. By and by the white beads get above the back ones. Brotz used a small vessel diameter (related both to bed height and bead diameter) and his fluidizing medium is water.

Do you think the quickly rotating paddle prevents the segregation of fine and coarse particles in Matheson's experiments or what else is the reason that gives the different behavior of fluidized two-component mixtures?

K. Schieferdecker

Leipzig, Germany

Author's Comment

Mr. Schieferdecker is disturbed by what he feels is an apparent discrepancy between published observations of particle segregation, leading to breakdown of homogeneity in fluid beds, versus the inter-particle friction mechanism in multi-component systems to which is attributed lower bed viscosity, leading to more homogeneous and smoother fluidization. He refers specifically to the segregation observations of W. Brotz (Chem. Ing. Tech. 24, No. 2, 1952) and the viscosity data of G. L. Matheson et al (Ind. and Eng. Chem. 41, 1099-1104, 1949) as analyzed for two component systems by H. Trawinski (Chem. Ing. Tech. 25, 201-3, 229-38, 1953) and extended to multicomponent systems in PETROLEUM REFINER 36, No. 5, 1957.

There are no discrepancies in these data and observations. The differences in bed behavior may be attributed principally to the geometry of the container vessels and the fluidizing medium.

The L/D of the bed described by Brotz was about 8.0 while that of Matheson's viscometer was more nearly 2.0 and at most 3.0. The effect of segregation would be more obvious and pronounced in a bed of high L/D than in one of low L/D where particles have a shorter path of travel from bottom to top or top to bottom.

The differences in the fluidizing media have an even stronger effect on the differences in bed behavior. With air or low pressure gas as the fluidizing medium, all the fluid in excess of that required for incipient fluidization passes through the bed as bubbles. Therefore the bed consists of a

NOW a Modern Fittings Package

one more reason for specifying
W-S FORGED STEEL FITTINGS

W-S Forged Steel Fittings are now being shipped in strong, lightweight fiberboard cartons designed to make purchasing a pleasure. Shipments are made up of unit cartons packaged inside a larger reinforced carton. It's easy... and advantageous to order your fittings in packaged quantities.

Here are additional advantages of the new W-S package:

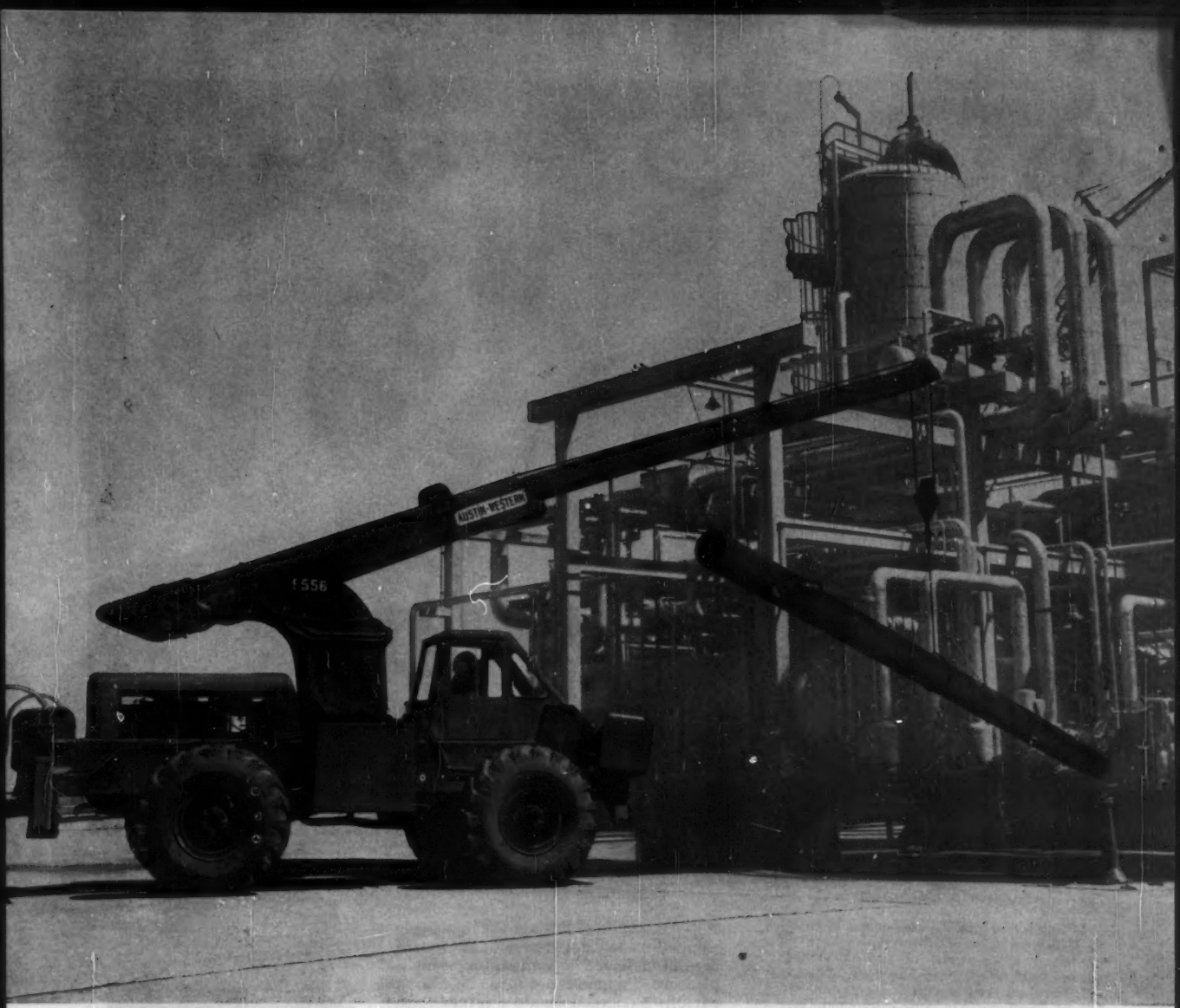
1. Compact and easy to handle.
2. Ideal for neat, efficient stacking on warehouse and stockroom shelves.
3. Sealed against dust and moisture.
4. Contents clearly marked on outside face of each carton, readily visible for prompt identification.

The new W-S package is only one of many reasons why W-S Forged Steel Fittings are the most widely accepted by industry.

Don't forget, too, W-S carbon steel fittings have the additional protection of their new blue synthetic coating. For detailed information on packaged lots ...and for a copy of our new fittings catalog, write today to W-S Fittings Division, H. K. Porter Company, Inc., Roselle, N. J.

Sold Through Leading Distributors

H. K. PORTER COMPANY, INC.
W-S FITTINGS DIVISION



One of 7 Austin-Western hydraulic cranes at Tidewater Oil Company's new Delaware City refinery shown hoisting a section of pipe at a catalytic cracking unit.

AUSTIN-WESTERN HYDRAULIC CRANE

One of Tidewater's most versatile construction and maintenance tools

Thirty-six Austin-Western hydraulic cranes helped build Tidewater's giant refinery near Delaware City, Del., and seven are now steadily employed handling materials and speeding repairs. They are among the most versatile construction and maintenance tools Tidewater has, and new jobs are being found for them every day.

Here are some of the ways Austin-Westerns save time and money on refinery operations: they remove heat exchanger heads and tubes quickly, eliminating the need for a larger crane or chain blocks; lift and transport pumps into the machine shop for repairs, spotting them precisely; unload freight cars, using their long, live booms fast and efficiently; transport materials with ease under lines in pump alleys and around pumphouses, over railroad tracks, in and out of buildings.

Find out how the flexible Austin-Western hydraulic crane can help you. See your nearby distributor or write direct.

Austin-Western CONSTRUCTION EQUIPMENT DIVISION, AURORA, ILL.

BALDWIN · LIMA · HAMILTON

Power graders • Motor sweepers • Road rollers • Hydraulic cranes

BALDWIN BLH LIMA-HAMILTON

The Mail Box . . .

matrix of dense material (barely fluidized) containing relatively large rapidly rising bubble-form voids. Within the matrix of dense material there is relatively little chance for particles to move any great distances, so that the mixing efforts occur primarily as a result of gross bulk movements within the bed as dense material fills the spaces formerly occupied by bubbles which have risen and then is again pushed up or aside as new bubbles come up from the bottom. A certain degree of particle movement is also afforded by the "raining" of particles through the bubbles while they are rising through the bed. With the superposition of a rotating paddle on such already gross mixing mechanisms in a very low L/D bed there is little wonder that segregation could not take effect.

When fluidizing with water (as in the experiments carried out by Brotz) there are no bubbles formed and the entire bed expands more uniformly, like an accordian, so that there is greater freedom of independent particles motion throughout the bed without the presence of so-called dense material having only an icipiently fluidized institial flow. Thus with liquid media there are no gross mixing mechanisms prevalent other than the hydraulic disturbances created within the fluid streamlines, and segregation has no impedances other than the particle slip velocity and minor interparticle collisions in traversing the bed length. The particle size and concentration effects noted by Matheson et al in their viscosity measurements with air as the fluidizing medium very likely not to be observed with water-fluidized beds. The Trawinski model should apply only to gas-fluidized beds in which dense material is traversed by bubbles.

Commercial FCC units are gas-fluidized systems of relatively low L/D so that the Trawinski model (or multicomponent extension: PETROLEUM REFINER 36, No. 5, 1957) would be expected to apply. In such units there is also a continual return of fines to the bottom of the bed via cyclone diplegs, in addition to a continuous catalyst circulation which brings the full spectrum of particle sizes in with the feed gases. All of these mechanisms normally overshadow any segregation tendencies.

F. A. Zenz

Roslyn Harbor, N. Y.

Quick! A Reprint

To the Editor:

We lent out our copy of the PETROLEUM REFINER for October, 1956 in connection with the splendid article on "Cooling Tower Specifications" by Ennis C. Smith. It has been lost, and we are wondering if you could help us to obtain either a copy of the PETROLEUM REFINER or preferably just a reprint of the article on "Cooling Tower Specifications."

Bill us for the charges and we will remit by return mail. We have been subscribers for over two years, almost three, and like your publication very much.

Frank K. Donnelly
F. K. Donnelly Co.

Seattle, Wash.

PR editors are always happy to receive letters containing timely comment about matters pertaining to the processing industry.

see how

you can obtain greater accuracy and reliability in fluid metering and proportioning

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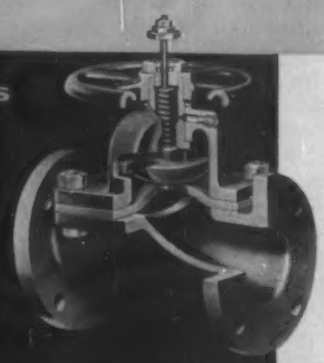
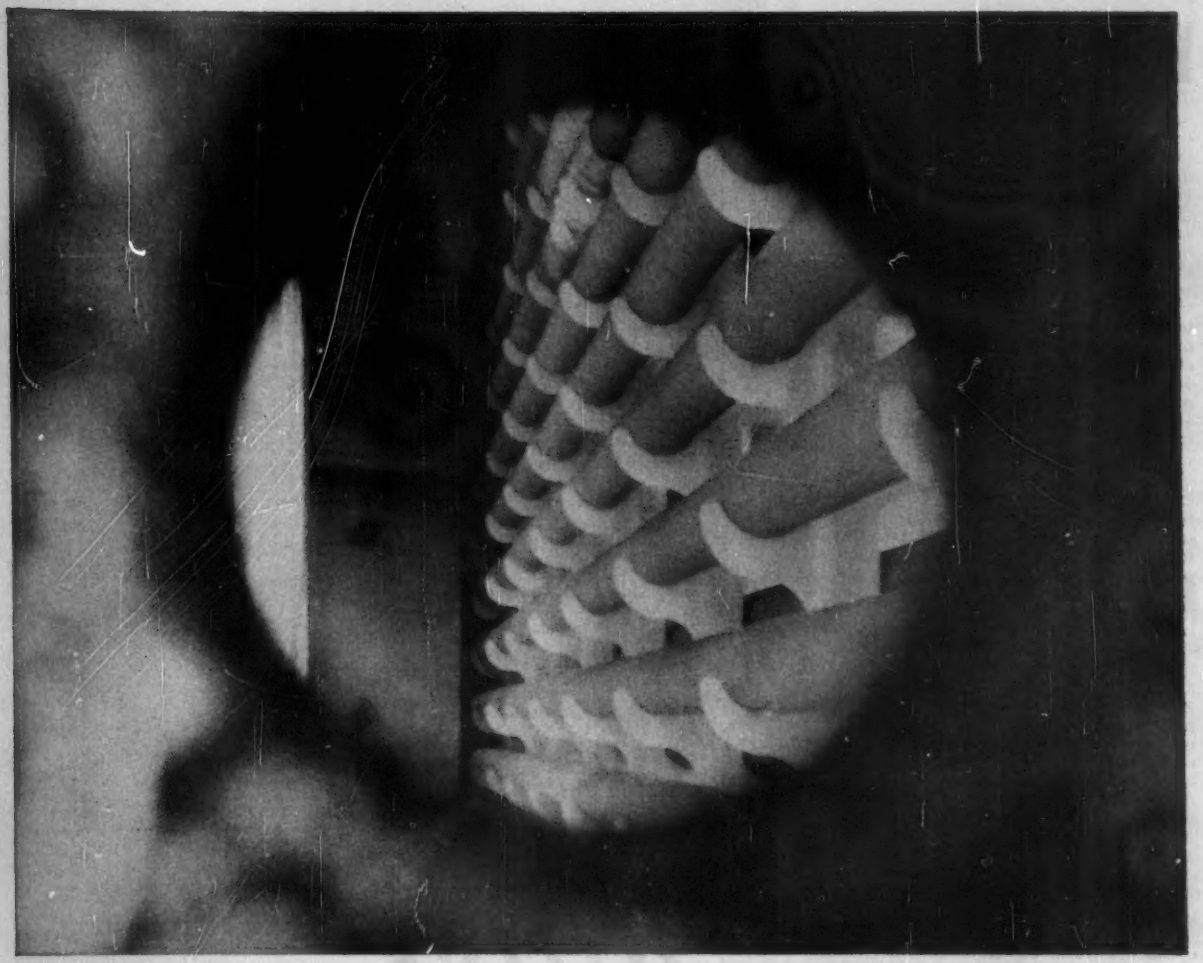


Hills-McCanna Company, 4614 W. Touhy Avenue, Chicago 30, Illinois

For more data on advertised products, use Readers' Service Cards, last page.



A peep inside shows...

Why Gulf puts Incoloy alloy tubes in hottest zone of heaters

The condition of these extruded Incoloy* nickel-chromium-iron alloy tubes speaks volumes.

No cracks. No warps. No thick scale. These tubes have seen thousands of hours of service in cracking hydrocarbons to produce ethylene at Gulf Oil Corporation's million-pound-per-day capacity Port Arthur plant. At this same plant their performance has been duplicated many times over.

After 9000 hours service from Incoloy alloy tubes in one group of furnaces, for example, Gulf stated: "Maintenance has been very slight ... mainly replacing one or two feet at the outlet end of several tubes" (an easy repair with weldable Incoloy alloy.)

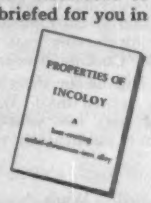
One thing that makes Incoloy alloy so reliable in this service is the stability of its austenitic structure. Another is its high resistance to carburization ... a safety factor during decoking.

Gulf also realizes a distinct price advantage in using Incoloy alloy tubing in the relatively inexpensive extruded form.

*Registered trademark

Booklet briefs Incoloy data

Information on the composition, properties, fabrication and heat treatment of Incoloy alloy have been briefed for you in the Inco booklet. "Properties of Incoloy." Let us know if you would like a copy ... or if Inco's Development and Research Division can be of service.



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Atlantic is proud to offer an advanced Catforming catalyst designed to economically produce higher octane gasolines . . . *and it can be utilized in your present equipment.* For more information, write, wire or call The Atlantic Refining Company, P. O. Box 8138, Philadelphia 1, Pennsylvania.

Higher gasoline octanes through Pentafining

You can convert the low-quality n-paraffins (C_5, C_6, C_7) in your gasoline pool to high octanes! Pentafining, the process developed by The Atlantic Refining Company, makes it possible. For full particulars, write today to The Atlantic Refining Company, P. O. Box 8138, Philadelphia 1, Pennsylvania.

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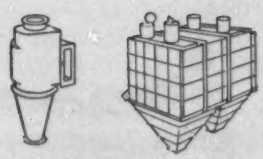
Buell Precipitator at mid-western cement plant.

Specialists in treatments for the flue

Hundreds of installations have proved the extra efficiency of Buell Dust Collection Systems. In mechanical collectors, only Buell cyclones have the exclusive Shave-off that traps an extra percentage of dust, large-diameter design that eliminates bridging and clogging. In electrical collectors, only Buell "SF" precipitators have features like high-emission, failure-proof Spiralectrodes. The results are high collection efficiency, freedom from shut-downs, minimum or no maintenance year after year in every Buell installation. Get the full story in "The Collection and Recovery of Industrial Dusts." Write Dept. **21-A**, Buell Engineering Company, Inc., 123 William Street, New York 38, New York.



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A Quick Look at the Industry THIS MONTH

Small Refiners See Tough Sledding Ahead . . . Excess product inventories, imports, recent military cutbacks in avgas purchases are making it harder for independents to compete in current soft market. Several small refiners have already sliced throughput to the bone.

Price pressures brought on by weak supply-demand position, plus '57 boost in crude prices, are forcing more small refiners to seriously consider making bids for crude imports.

Recent cut in government's avgas purchases puts another roadblock in path of independent's effort to stay solvent, i.e., Cosden is putting its Hawley refinery on standby basis, and will use capacity freed at Big Spring to meet its marketing needs.

Even large refiners are being hurt. Tidewater has cut its throughput 40 percent at its 108,000-barrels-per-day, Associated, Calif., refinery—and may be forced to lay off up to 200 employes early in '58. Reason: Recent military cutbacks cancelled several large fuel oil and avgas contracts.

Another Step Toward Automatic Control . . . Texaco has installed its first digital computer made specifically for fully automatic control of refinery processes. System will be used to control polymerization at Port Arthur refinery. Officials say new computer will provide greater quality control, increase plant output and reduce operating costs—without cutting number of employes now operating polymerization unit.

Refinery computers are getting larger. Though most are now of the digital type, analog computers are finding their place. Monsanto Chemical recently installed one of the large-sized analog systems. It will be used to solve problems of production and research.

Postings on Octane Race . . . Ethyl survey of major U. S. cities shows premium octanes averaged 98.4 for December, same as the November average. Regular is also up 0.1 octane for a December average of 91.1.

Alkylation is being thrown into the scramble for higher octanes. (See Page 233.) Some refiners are looking into possibility of akylating wider range of olefins — even including ethylene.

Is Fuel Economy the Latest Trend? . . . Recent statement of American Motors President George Romney offers refiners some food for thought. Says he, "American motorists are finding it harder to support the cars to which they have become accustomed, and as a result are seeking more fuel economy. As small cars increase in numbers, need for super-premium and premium fuels will decrease."

In support of his statement, Romney pointed to recent upsurge in sales of imported "doodlebugs"—also sharp increase in recent months of American Motor's Rambler.

Chrysler Corp. is offering fuel injection as optional equipment in four '58 cars. Chrysler's differs from other injectors by using electrical pulses instead of mechanical devices in controlling flow of gasoline to engine cylinders. General Motors offered fuel injection in two of its '57 models. Major advantage: Improved fuel economy by better distribution of fuel-air mixture in the cylinders.

Industry Gears to Slower Pace . . . Economists say "restraint" should be industry's by-word in '58. To maintain sound economic position, refiners will have to hold crude runs to 7,850,000 barrels per day at least until April 1—3.5 percent under last year's average. Predictions are that first quarter demand will be 315-350,000 barrels per day under same '57 period.

Estimates for over-all '58 demand increase are averaging between 2.5 and 3 percent over '57. This factor, combined with lower production rates and import levels, will help ease excess crude and product inventories later in the year. However, gasoline and residual stocks will continue to be major problem if runs are not cut back sharply in first quarter.

Lower Prices for Natural Rubber . . . Latest reports indicate natural rubber may again give synthetic rubber a stiff price battle. Current prices for natural are 26-28 cents per pound, with synthetic averaging 25 cents per pound.

However, another report shows average cost of natural rubber landed in London is 26.6 cents per pound—before profits of any kind. This is average, with costs ranging from 19.1 to 34 cents. This could mean that again natural rubber producers will have to increase selling price of their product.

New Acetylene Process Looks Promising . . . Tennessee Eastman has announced successful pilot plant operation of an acetylene process based on combustion gas prolysis. Good yields of acetylene and ethylene are reported using propane and natural gasoline as cracking stocks. Air, enriched air or bulk oxygen can be used with reaction conditions and yields controlled by pre-heat temperature of cracking stocks.

Several experimental furnaces have been built and successfully operated for periods up to 12 months. Acetylene and ethylene products have proved to be readily recoverable and easily purified using conventional methods.

Quick Look at Washington . . . Early indications are that 18 West Coast oil companies will comply with request to join Eisenhower's voluntary imports plan . . . **Justice Department has set next Nov. 12** as date it will start antitrust trial against seven West Coast companies, alleging their present consignment contract for retail gasoline selling enables them to fix prices and subsidize dealers competing with independents . . . **American Municipal Association,** national organization for city officials, has turned thumbs down on motion that it go on record favoring federal control of natural gas producers . . . **Commerce Department reports ethylene glycol production** jumped from 597 million lbs. in '51 to 1.18 billion in '57—more than 80 percent was used in anti-freeze.

Refiners Take New Look at Crude Values . . . After more than 50 years, refiners are starting to speak out against unrealistic price they have to pay for crude when its value is based on API gravity alone. According to Universal Oil Products, a more realistic evaluation can be obtained by basing a crude's value on its four distillation fractions. Reason: UOP reports the cost of processing two crudes with same API gravity can vary as much as 21 cents per barrel within one process unit.

Needed: Way to Control Auto Exhaust Gases . . . Despite much research, no satisfactory way has been found to control auto exhaust gases that produce smog. But, it's certain unburned hydrocarbons and oxides of nitrogen are the problem. Best bet to-date: Either burn the hydrocarbons after they leave the engine, or remove nitric oxide in the exhaust system.

LPG Demand Continues Upward . . . '57 liquid petroleum gas sales increased at slower rate than in previous years, but still did better than most other oil products. Demand increased 4.1 percent over '56, compared with increases of 10.6 percent in '56 and 17 percent in '55. Marketed production totaled 6.9 billion gallons in '57.

In Keeping With Growing Demand . . . Several suppliers upped propane prices 0.5 cents to present 5¢ cents per gallon in the Mid-Continent area last month. This was third price increase in '57.

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How Suntide Refining blends products in tanks holding up to 200,000 barrels

Some of the largest tanks ever mixed can be found at Suntide Refining Company's plant in Corpus Christi, Texas. Suntide performs a variety of blending operations in these tanks—equipped in some cases with *five* LIGHTNIN Mixers.

Many of these LIGHTNINS have been in service for four years, blending a wide variety of products: diesel oil, crude, jet fuel, and leaded gasoline. Suntide reports that the mixers have operated continually during that time *without a single failure* of any part including the mechanical seals.

Low-cost maintenance

A mechanical seal, optional equipment on any new LIGHTNIN Side Entering Mixer, is one feature of the mixers installed at Suntide Refining. It can save refiners thousands of dollars per year on big tank mixer maintenance.

The LIGHTNIN Mechanical Seal Mixer eliminates stuffing box repacking, and *never* needs shaft seal adjustment. And the seal can be replaced in a few minutes —even under a full head of liquid in the tank—without dismantling or removing the mixer from the tank!

Exact mixing results

Not all tanks require five large side entering mixers, of course. In many cases, only one LIGHTNIN will blend products to full uniformity in a matter of minutes.

Your LIGHTNIN representative can tell you exactly what mixing action is required to do the job at your refinery. His recommendations are based on data accumulated over many years of Mixco research.

Get just-right mixing in all of your tanks—big or small—by installing LIGHTNIN Mixers. For more information, contact your nearest LIGHTNIN Mixer representative (he's listed in Composite Catalog). Or write us direct.

"These mixers have been running since October 1953, without a single failure of any part including the mechanical seals," says transfer foreman Ray B. Dunn. He's referring to the LIGHTNIN Mixers installed at Suntide Refining Company's Corpus Christi plant.

"Lightnin® Mixers"

MIXCO fluid mixing specialists

FOR LATEST MIXING INFORMATION and full description of LIGHTNIN Mixers, send for these helpful bulletins:

- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ LIGHTNIN Rotary Mechanical Seals for extra low cost mixing
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- ☐ Condensed catalog showing all types (B-109)
- ☐ Data sheet for figuring mixer requirements (B-107)

Check, clip, and mail with your name, title, company address to:

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Keeping Mighty America's Might

P. M. Shoemaker, President
The Delaware, Lakawanna and Western Railroad Company, New York

WHEN THE HISTORIAN of the distant future makes the same kind of cold-blooded appraisal of our era as we do of Greece and the Peloponnesian War he will doubtless stress one outstanding fact; that Western Civilization was saved in two world wars by the production of American factories and farms. Moreover there is little doubt that American industrial and agricultural might also stopped the aggressive Russians in the cold war.

No matter how you look at it this free American economy of ours stands out dramatically in world history. It has produced the greatest abundance of goods along with the greatest buying power ever known to man and these have combined to give us the highest standard of living. Meanwhile it has allowed Americans to enjoy more personal freedom and more individual dignity than ever experienced by any other people.

This American economy is based firmly on private enterprise, regulated only when necessary to prevent monopoly or to stimulate competition. The past 170 years prove that it is admirably suited to the American character with its genius for getting things done, allows initiative and inventiveness to the full, and equal opportunity for all. Under it the United States has grown from 13 struggling and impoverished states on the edge of the continental wilderness into the most powerful nation of all time.

One would think that Americans without exception would stand behind this system of ours. They do generally, but there is a small and noisy minority not without influence in government, that insists government can do a better job on production than can private industry. These include more than the Marxists and other collectivists; they include those behind expansion of the federal government in areas properly belonging to the states, the headlong encroachments of public power, and the proponents of big government. Many of these would resent being called Socialists, yet at times it is difficult to see wherein they differ.

The average businessman does not realize how far the federal government has gone into direct competition with him, how far it has moved in the direction of the welfare state, state capitalism, or the Socialist state.

A survey by the Bureau of the Budget late in 1956 disclosed that the government owns 19,711 commercial or industrial-type business enterprises. Such projects, except in rare cases, pay no taxes, pay no interest on invested capital, seldom charge depreciation, and not infrequently their directing personnel are military or naval officers and are not on their payrolls. So claims of financial success made for them are usually phoney. Besides they deny the government the taxes that would accrue from private enterprise. Definitely they are unfair competition to all tax-paying private enterprises.

Many of these federal enterprises were started during the emergencies caused by World War I, the depression, and World War II. At the start, most of them served a useful purpose; the trouble is that most of them have outlived the purpose for which they were founded but continue their wasteful and insufficient operations. Such enterprises are easy to start, but difficult to halt. They tend to perpetuate themselves for their personnel want their jobs and often have the support of pressure groups.

Congress recognized this situation when it set up the Second Hoover Commission in 1953. Among the duties it imposed on the Commission was the eliminating of "non-essential services, functions, and activities which are competitive with private enterprise."

The Hoover Commission set up two sub-committees of experts, one to deal with the Department of Defense under Joseph B. Hall, president of The Kroger Company, to study the problem. These experts came up with startling information as to the extent of the government's operations. They found

Authority:

The REFINER asked the U. S. Chamber of Commerce for the names of some outstanding business leaders who might "talk turkey" to PR readers about the Hoover Report. Mr. Shoemaker's name led the list of those submitted, and small wonder! Because he was chairman of the Hoover Commission Task Force on Transportation and served as a member of four other task forces. He probably contributed more time and effort to the work of the Commission than any other businessman. He is a member of the Chamber's Committee on National Defense and was the Chamber's witness on the 1958 defense budget during the recent session of Congress.

Here's proof of the solubilizing power of FOA-2

Du Pont Fuel Oil Additive No. 2 has long been known as an exceedingly effective fuel oil stabilizer, sludge dispersant and solubilizer. These qualities have been repeatedly demonstrated in field performance, and now the solubilizing power of the additive can be demonstrated in the laboratory as well.

The demonstration is quite simple and can be made with no more equipment than a heat source (steam bath) and two small vials of fuel. The fuel is kerosine with a small amount of benzene containing dissolved sludge. FOA-2 is added to one of the fuel samples; then the benzene is boiled off of both samples. The time-lapse pictures at the right tell the story.

How FOA-2 solubilizes

The photos show that at the beginning sludge is soluble in the fuel, becoming insoluble only when the aromatic solvent portion (benzene) is removed. The right-hand bottle shows that FOA-2 keeps the sludge soluble, whereas it gradually precipitates in the bottle at left.

FOA-2 is a long-chain polymer with a critical balance between polar and oil-soluble groups. The polar groups are attracted to non-hydrocarbon constituents or residue particles, and the soluble groups maintain good oil solubility of the combination.

FOA-2 *stabilizes* fuel by preventing interaction of non-hydrocarbon constituents or residue formers in the fuel. It *solubilizes* some residues which are just slightly insoluble, and *disperses* other residue particles which are quite oil-insoluble.

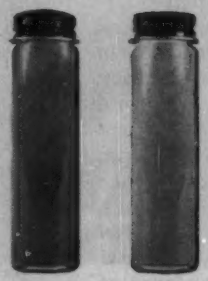
Benefits of the additive

These three properties of Du Pont Fuel Oil Additive No. 2 keep oils free flowing . . . devoid of sludge which could cause clogging of heating systems.

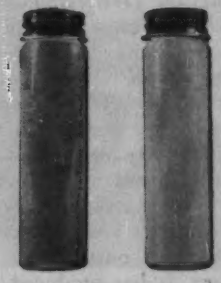
They are responsible also for FOA-2's solution of the incompatibility problem. The sludge likely to precipitate when oils are mixed does not form if sufficient FOA-2 is present; 30 lb./1,000 bbl. is usually enough to prevent incompatibility.

The third important function of the additive is its cleansing of systems already fouled with sludge. This saves the costs of downtime and of having systems cleaned manually.

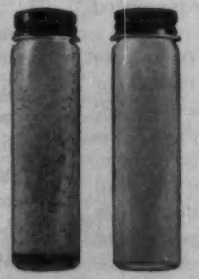
1. 10:30 a.m., September 23, 1957: These bottles both contain 99% kerosine, 1% benzene and a small amount of sludge (15 mg/100 ml) which is soluble in the fuel blend. To the bottle at right 0.01% of Du Pont FOA-2 has been added. This is the proportion recommended for protecting fuel oils (30 lb./1,000 bbl.).



2. 10:42 a.m., same day: The samples have been heated for 10 minutes in boiling water to evaporate the benzene. Sludge is already starting to appear in the bottle at left, not in bottle at right.



3. 11:42 a.m., same day: Note in cut 3 agglomeration of insoluble sludge particles at left, and clarity of FOA-2 protected oil at right.



4. 1 p.m., same day: Some sludge has settled to bottom. Solution at right remains clear.

5. 10:30 a.m., next day: Most of the small sludge particles in left-hand bottle have now settled. After 24 hours, FOA-2 protected oil still shows no sign of sludge precipitation, and will continue clear almost indefinitely.

New book about FOA-2

We recently published a comprehensive 28-page book about FOA-2. All the basic information you will need is included—properties, composition, use concentrations, handling and addition methods, and performance testing data. Ask any of our representatives for a copy, or drop us a line.

* * *

WILLIAM T. ROBINSON is head of the group at the main Du Pont Petroleum Laboratory engaged in technical work on gasoline and fuel oil additives.

For the past five years, he has been closely associated with the development and application of Du Pont FOA-2. In addition to his activities at the Laboratory, he has worked closely with refiners on the effective use of this additive.

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that the investment "probably exceeds" $15 billion. They found more than 2500 such enterprises in the Department of Defense alone, with a variety of operations such as tree nurseries, motion picture studios, saw mills, spectacle manufacturers, cement-mixing plants, railroads, steamship lines, air transports, and what not. Besides these, the government was head-long into banking, insurance, housing and numerous other functions.

Some of the activities made little sense from a government point of view. For instance the Commission's experts found that while the government pays millions of dollars yearly in subsidies to keep ship lines and airlines in operation the Army, Air Force and the Navy operate lines in direct competition with them so they could not possibly be profitable and must have the subsidies.

The Hoover Commission itself made its report to the Congress in May, 1955. It offered 22 recommendations to ease the unfair competition with private enterprise. It should be stressed that the Commission recognized that certain of these government projects are necessary, such as arsenals, but it did definitely conclude that the government is "conducting a multitude of operations in competition with and to the injury of the very system on which our future security and prosperity is based."

What has been done about the 22 points?

There has been some progress in the executive branch of the government. Director of the Budget Brundage reports that 532 business-type enterprises have been closed and that 161 more are being closed. These are mostly operations like laundries, bakeries, meat-cutting plants, and paint factories, but there has also been progress in the ending of the RFC, the sale of the synthetic rubber plants, and the disposal of the Mississippi River barges. While this is gratifying, it is only a beginning. More, much more, remains to be done.

What can you do about it? Well you can exercise your right as a citizen and taxpayer and write to the President or the Director of the Budget, and ask for further action by the administration on the Hoover recommendations. So far the Congress has done almost nothing. You can write to your Senators and to your Congressman and tell them you want action on S. 1539, the bill introduced in the Senate, and H.R. 5826, the bill introduced in the House, to implement the Hoover recommendations on free enterprise. They will be up again for action in the session of the Congress opening in January, and now is the time to get behind them.

If you don't like the idea of unfair competition from your government you can get rid of it by supporting the Hoover Report.

A Salute for The AIChE

FIFTY-THREE YEARS AGO, a technical publication editor called for the formation of a national organization for chemical engineers. He said such a group was justified because, "the profession is now a recognized one and there are probably *500 chemical engineers* in the country."

That editor was prophetic in every way. Chemical engineers have more than proved their right to professionalism—for they have contributed as much or more than any other group to 20th century progress.

The editor's idea for a professional society of chemical engineers came true just three years later. In June of 1908, the American Institute of Chemical Engineers was formed in Philadelphia with 40 active members.

Next June 22-27, the nearly 16,000 members of AIChE (membership has doubled since the group celebrated its 40th anniversary in 1948) will observe the Golden Anniversary of their organization right back where everything started—in Philadelphia. Plans include a special plaque ceremony at the Engineers' Club where the organization was conceived. Addresses by leaders of industry and a topflight representative of the federal government will be heard by the record number of members who plan to be in attendance.

PETROLEUM REFINER offers its congratulations to the members of AIChE as they enter their Golden Anniversary year.

For the benefit of our nation, let us all hope that AIChE will at least double its membership again by the time the 60th Anniversary year rolls around.

Industry Faces Balancing Task

IN 1958 THE OIL INDUSTRY will continue to have the serious problem of holding oil supplies within the limits imposed by lagging demand. This balancing of supply with demand must be achieved if industry operations are to be satisfactorily profitable.

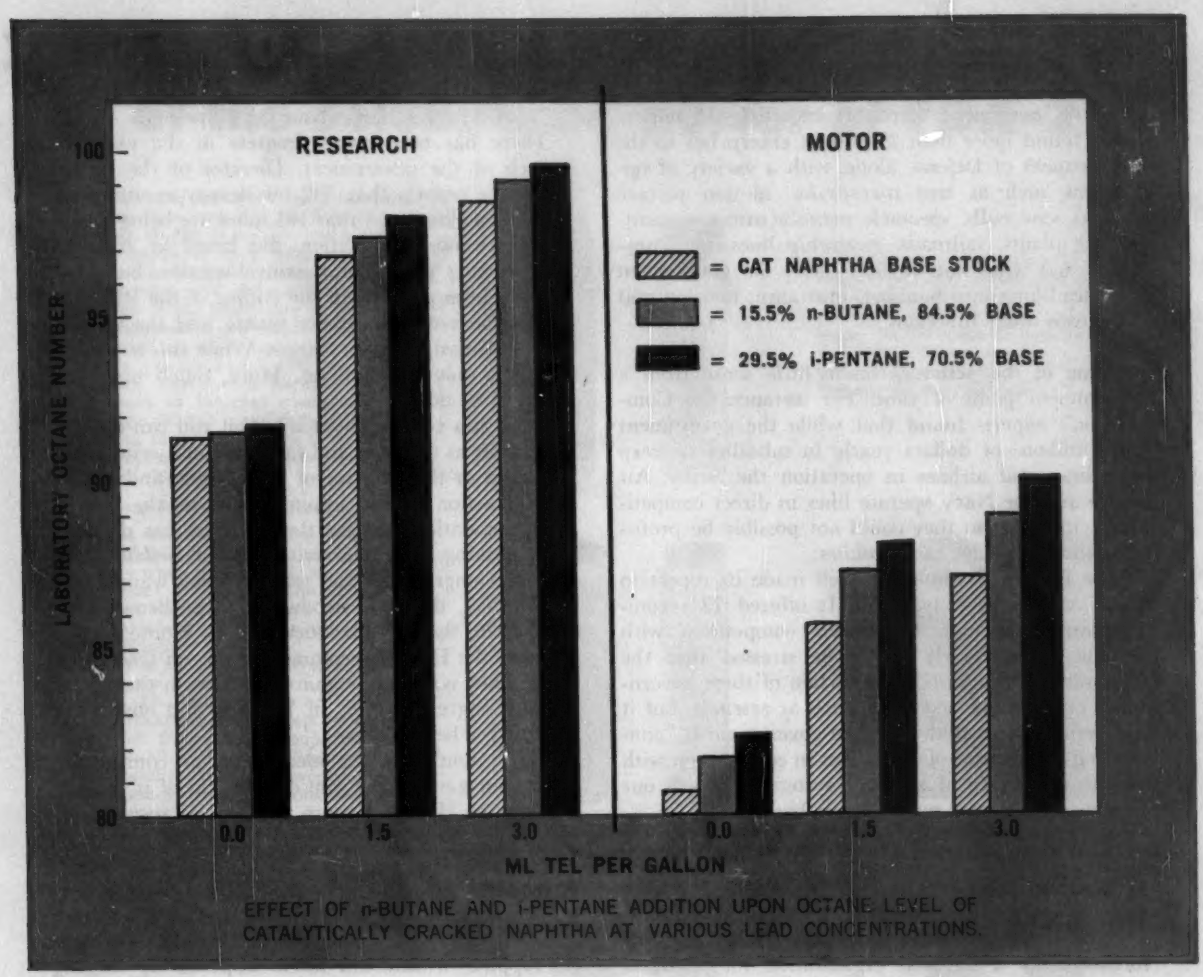
Petroleum demand normally increases around 4 to 6 percent annually. But in 1957 it was disappointing. In 1958 it will again be subnormal.

Total domestic and export demand for petroleum in the three months, September through November, 1957, was down 232,000 barrels daily—or 2.5 percent from the year-before level, the Independent Petroleum Association of America calculated. Exports were off 31.5 percent from late 1956, when the Suez crisis caused the export of petroleum from the U. S. to assume abnormally large proportions, this so that the economy of European countries would not be entirely disrupted.

Domestic petroleum consumption in the September-November period of 1957 averaged only 8,590,000 barrels a day, or 1 percent, less than usage in the same months of last year, IPAA stated.

If continued, said IPAA, the disappointing fourth quarter demand trend would require lowering of its forecast of 9,935,000 barrels daily for domestic consumption in the first quarter of the new year.

Total demand, domestic and export, in the the first quarter of 1958 is expected by IPAA to average 10,250,000 barrels daily, a decline of 368,000 barrels a day, or 3.5 percent, from 1957's first quarter.



EFFECT OF n-BUTANE AND i-PENTANE ADDITION UPON OCTANE LEVEL OF CATALYTICALLY CRACKED NAPHTHA AT VARIOUS LEAD CONCENTRATIONS.

Ethyl Research Makes Precise Study of Butane and Pentane Blending

At TODAY's high-octane levels, the use of gasoline blending components in the most economic manner has taken on an ever-increasing importance to the refiner. One phase of refinery blending which has commanded continuous interest is the addition of light hydrocarbon agents to gasoline stocks for vapor pressure adjustment to yield finished motor fuels.

The best economic use of available pressurizing agents is determined to a great extent by their volatility and octane blending characteristics in various refinery stocks.

Thus, in order to establish best conditions for the pressurization of gasoline, accurate knowledge of the blending characteristics of those components employed as volatility correctors is required. Ethyl Corporation's refinery technologists can assist you in determining the most economical use of your pressurizing stocks.

For example, in a recent program, a refiner wanted to know the blending octane qualities of normal butane and isopentane when used individually as vapor pressure correctors in three base stocks—alkylate, catalytic reformate, and catalytically cracked naphtha. The objective was to find the break-even economic values of these agents as blend stocks through the use of correct blending qualities.

Blending Carried Out Under Refrigeration

Due to the critical nature of butane and pentane concentration, all blending operations were conducted in a refrigerated room (ambient air temperature, 30-35°F.) to minimize loss of agent, particularly that of n-butane. Blending was carried out on a weight basis in order to give the percentages desired.

Operations were designed to obtain representative samples for analysis and to minimize loss of material from closed containers after samples had been taken.

Exact Concentrations of Pressurizing Agents Determined by Vapor Fractionation

An accurate knowledge of the concentration of pressurizing agent in a base stock both before and after blending was needed to calculate reliable blending octane values.

Suitable techniques were developed for the exact determination of butane and pentane percentages by the use of gas chromatographic apparatus available at Ethyl's Detroit Research Laboratories.

Statistical Design Used in Obtaining Engine Ratings

Triple Research and Motor ratings were conducted on each fuel at TEL levels of 0.0, 1.5 and 3.0 ml per gallon. In order to insure completely independent determinations, each rating was conducted on coded samples which were rated in a pre-established sequence. The day-to-day variation in the CFR engine was avoided by rating all the samples on one base stock during one day's operation.

Gas chromatographic apparatus determines exact concentrations of pressurizing agents in base stock.

Engine ratings were made according to a statistical design in order to assure reproducible results. The standard deviation for the overall program was 0.20 octane number for the Research and 0.39 for the Motor method, showing good replication.

Laboratory Results Yield Octane Blending Data

Typical results of this study are shown in the bar chart on the opposite page, wherein the effects of n-butane and i-pentane additions upon octane level are shown for catalytically-cracked naphtha at various lead concentrations. From these results, the Research and Motor octane blending values have been calculated and are compared in the table (below).

At the maximum practical concentrations employed, i-pentane and n-butane possess essentially the same Research octane blending qualities at 0.0 and 1.5 ml TEL per gallon, while n-butane excels at the 3.0 ml TEL level. In every case, however, n-butane exhibits higher Motor octane qualities than does i-pentane.

Thus, while the two agents are about equal with regard to Research octane effectiveness at the percentages employed, n-butane would be preferred for this base stock when the maximum Motor octane effectiveness per quantity of agent added is an important factor.

Armed also with blending octane values derived for alkylate and catalytic reformate, the relative economic value of n-butane versus i-pentane for blending can be ascertained on the basis of octane efficiency for the refinery stocks in question.

The above program was designed primarily to show the effects of n-butane and i-pentane at concentrations approaching the Reid Vapor Pressure limits of the CFR engine. While some indication of the effects at intermediate percentages can be gained, exact blending values for a particular fuel at a given pressurizing agent concentration must be obtained by individual laboratory evaluation.

The data obtained from this type of study also permit the determination of blending Reid Vapor Pressure values for the pressurizing agents in question in various gasoline stocks.

BLENDING OCTANE VALUES OF n-BUTANE AND i-PENTANE IN CATALYTICALLY CRACKED NAPHTHA

Volume % * Agent in Base	Research O.N. @ ml TEL			Motor O.N. @ ml TEL		
	0.0	1.5	3.0	0.0	1.5	3.0
15.5% n-butane	92.1	100.3	102.2	86.8	95.3	98.4
29.5% i-pentane	92.3	100.2	101.5	86.4	93.6	96.7

*Maximum practical concentration.

How Ethyl Research is helping you

This study is another example of the professional services available to the refiner through Ethyl Corporation's Refinery Technology Program.

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THEY HELPED PLAN THIS ISSUE. The 1958 Maintenance Issue editorial conference was held to establish the limits and type of editorial content for this issue. Attending the conference were the industry experts shown above, left to right: A. E. Shaw, Sinclair Refining Company; A. C. Learned, Dow Chemical Company; Elmo Johnson, Diamond Alkali Company; R. W. Lortz, Phillips Petroleum Company; Jodie Isenhower, Humble Oil & Refining Company; and Ray O'Brian, Shell Oil Company.*

1958 Maintenance Report

Maintenance costs are up. PETROLEUM REFINER's Market Research department predicts that the refining-petrochemical maintenance costs in the U. S. for 1958 will be $120 million *more* than 1957. The total U. S. cost is estimated at *more than a billion dollars.*

Top management is gravely concerned with these staggering expenses and expects an all-out effort to hold or reduce this budget-consuming giant.

Over half of these costs is labor. Thus, the theme for this issue is: Labor-Saving Ways to Cut Maintenance Costs.

How can labor costs be reduced with operations becoming more complex? The first approach is found in the design stage of a unit. More attention must be given to design, from a maintenance standpoint. The layout, the equipment itself and the connecting piping must be designed with labor in mind to reduce maintenance costs.

The next approach is to check up on your maintenance training program. It must be top-notch to expect a reduction in labor costs because skill is now as essential as bailing wire was to the oldtime mechanic.

The third approach to maintenance labor cost reduction is through better planning and scheduling. Regardless of how good the equipment is or how well the men are trained, neither will reduce maintenance costs if the shutdowns and routine maintenance operations are not planned properly.

***The attendance by executives, engineers, superintendents or other employees of oil companies at these editorial conferences does not constitute an endorsement of the REFINER or any other publication. The fact that these industry leaders are allowed to attend the planning conferences shows the interest which companies have in the planning of sound editorial content for the industry.**

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An interview with front line supervisor Lonnie Dye

A Foreman Looks at Maintenance

Are you rotating your maintenance jobs the way a foreman would? Check up on your program from a morale standpoint.

A specialist who has made a study of this question is Lonnie Dye. He has approached the subject of maintenance morale from the standpoint of a foreman. He has worked at the dirty and good jobs himself and knows the inner feelings of the maintenance mechanic.

In this exclusive interview, held at Spencer's plant in Orange, Texas, Dye reveals the genuine insight that a foreman feels for his work and his men.

Q. *Is maintenance becoming, more and more, a major problem?*

A. I definitely think so, especially at the accuracies of control which the plants are trying to operate.

Q. *What do you look for in selecting a new foreman from a group of mechanics?*

A. He must know his job real well and learn other maintenance jobs. He must get along with people and know how to handle men.

Q. *How can a mechanic learn to handle men unless he is a foreman?*

A. We give a mechanic a job with one or two men working with him and although he is not acting as a supervisor, we can tell by watching how he handles the job if he will make a good supervisor.

Q. *What does it take to increase maintenance morale?*

A. We try to equalize all of the hard or dirty jobs. That is, we rotate them so that all the people are involved. No one individual gets all the dirty jobs or all the good jobs. This is a major morale builder. Another part of this subject is to talk with the men and try to help them. If they have a problem, personal or on-the-job problems, I try to help them. It's difficult, sometimes, to give personal advice, but I think it's part of my obligation to the men and I give the best advice I can.

Q. *Is there any problem in picking the optimum between strict discipline and the casual "friendly-joe" approach?*

A. I probably try to be friendly more than strict which may be the wrong approach. But, I don't think that strict discipline, where you are looking down a man's collar all the time, is necessary. But if you have rules set-up, the supervisor must talk to the man about it, if he violates the rule.

Q. *Do you have any problem, after being friendly, in having to "chew-the-man-out"?*

A. Yes, this is always a problem; but you have to grit your teeth and do your job. An in-between approach in discipline is the best—not too strict, not too friendly. If you talk to one man more than the others, there can be hard feelings.

Q. *What would you tell a man to do if he doesn't like his job?*

A. I would tell him to do the best he can at what he is doing. Then, if another job opens up that he would like to do, we will know he can do a very good job at it because he has worked hard and well on something that he doesn't like to do.

Q. *How should a front line supervisor train his men?*

A foreman says this . . .

"We try to equalize all of the hard or dirty jobs. No one individual gets all the dirty jobs or all the good jobs.

"If a mechanic doesen't like the work he is doing, I tell him to do the best job he can do so that when a job of the type he likes opens up, his supervisors will pick him as a good worker.

"I don't think that strict discipline, where you are looking down a man's collar all the time, is necessary."

LONNIE DYE is a maintenance supervisor at the Orange, Texas, works of Spencer Chemical Company. He has been in the maintenance field since World War II, joining the instrument and electrical equipment maintenance section of The Texas Company refinery in San Antonio in 1945. In 1953 he became associated with Spencer's Vicksburg ammonia plant as supervisor of the instrument and electrical group.

Dye went to England in 1954 to observe start-up and maintenance procedures of the high pressure polyethylene process.

A. Some people can pick up information on equipment faster than others. So, we send them to learn the equipment first. For example, a factory representative comes to the plant and teaches our man about a particular piece of equipment. As soon as he understands it and his time is available, he passes the information on how to maintain this equipment to the rest of the men in the plant.

Q. *Has increased automation prevented unusual instrument maintenance problems?*

A. The electronics instruments have created a problem in getting the men trained in the proper maintenance procedures. This is one of the biggest maintenance problems.

Q. *Do you get enough information on maintenance of these instruments from manufacturers?*

A. On some, yes. On others, no. A lot of times, we have to contact the manufacturer and get them to come in and give us on-the-job training.

Q. *Do you feel that in the future, more engineers will be required in a maintenance program?*

A. Specialized training will be required, and more engineers in the maintenance department will be required in the future.

Q. *Are safety slogans effective among men in a plant?*

A. Slogans are not too effective. But the safety program is effective. We find that the best method is to continually remind the men concerning safety hazards.

Q. *Are drilled-in safety procedures the most effective in teaching safety?*

A. Yes. It is brought up often and is more effective and mechanics do not forget the drilled-in procedures.

Q. *Is there a need for more labor saving tools?*

A. Yes, it has been proven that the job can be done cheaper, increase production, and in our case, give less contamination of product.

Q. *Does inspection reduce maintenance operations?*

A. I believe inspectors pay off especially in the operation of high pressure equipment, because it's very necessary to have this equipment to do the job right.

Q. *Could inspection increase maintenance costs?*

A. You could get to the point where there is too much inspection.

Q. *Are history cards on equipment helpful?*

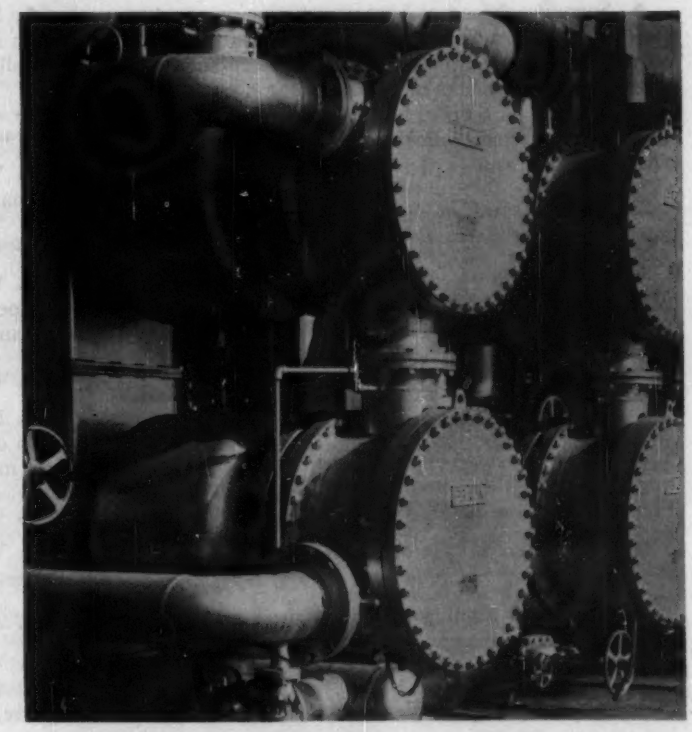
A. Yes, I think that cards should be used on all equipment to determine the cause of failures, nature of the failure, and the expense of maintaining this equipment.

FIGURE 1—Ample width accessways through operating areas do more than let mobile equipment into such areas. They provide maintenance work space, easy access to equipment and increased safety. And, during turnarounds, space is at a premium.

How Good Design Reduces Maintenance

Whether it's new equipment, a new unit or a new refinery, good design will reduce subsequent maintenance costs.

FIGURE 2—Annular distributors on the exchanger shell make tube-bundles of the same size exchangers, truly interchangeable.



Henry P. Evans and Ditmas Bromley
C F Braun and Company
Alhambra, California

ALMOST EVERY process unit has to be opened up, cleaned, inspected and repaired at more or less regular intervals. Design can cut maintenance costs by planning for this repetitive work, by providing ample access when laying out an operating area, by seeing that manufacturers provide aids to maintenance in their equipment designs, by providing the working space needed for maintenance and by calling for built-in handling facilities where they may be needed. These design provisions for maintenance should be based on up-to-date experience and should be economically sound. A separate specification clearly spelling out the maintenance aids to be built into new equipment, a new unit, or a new refinery, is the best way to assure sound and economic design for maintenance.

Process Units. Engineers strive constantly to design process units that stay on stream for longer periods and have fewer unscheduled shutdowns; they have made much progress in this direction. Today's designs usually call for alloys where needed, provide spares for essential equipment and specify more realistic fouling factors. Regardless of how well designed mechanically and process-wise, units must be opened up, cleaned, inspected, and repaired at more or less regular intervals.

This repetitive work on the same units, year after year, offers a splendid opportunity to cut the cost of maintenance. If, in the design of a unit, provisions are made for this repetitive work, then maintenance can really be speeded up and simplified. Designing for maintenance usually increases the first cost of a unit, even though each provision is checked and found economically justified. Surprisingly, though, this incremental investment often saves so many expense dollars that it has a better payout than the over-all investment in the process unit.

Costs can be cut best by designing for this repetitive work when a process unit is still an embryo. When laying out a unit, designers can provide easy access for the maintenance men to move in with their tools and mobile equipment. Manufacturers can design their process equipment so that it's easier to open up, to clean, and to remove parts when necessary. Designers can provide clear space around equipment and work areas in units. Where process equipment may be difficult to reach by crane, designers can call for built-in facilities to handle such equipment.

FIGURE 3—On bubble columns, good maintenance design calls for properly spaced manholes, hinged manhole covers, liberally sized platforms and for putting a well designed davit atop those columns needing built-in handling.

Layout of Areas. For access, each operating area should have paved roads along all four of its sides. Operating area is considered a unit or, more usually, a group of units occupying a space roughly 300 feet by 500 feet. Movement from the access roads into an operating area shouldn't be blocked by sleepered pipeways, vertical-face curbs or drainage ditches with steep sides.

A paved accessway, 20 to 30 feet wide, should run completely through an operating area from one road to the parallel road, opposite (Figure 1). This accessway should run through or be adjacent to all process units in

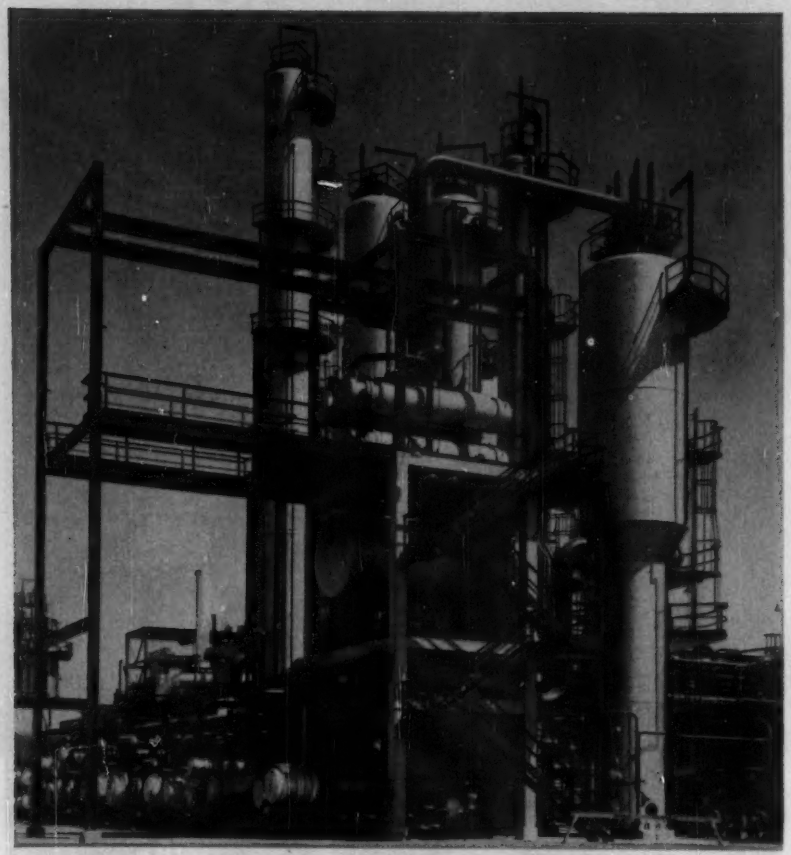


FIGURE 4—High exchangers often need a built-in monorail structure which makes handling of tube bundles a fast and safe job.

the operating area. A dead end on such an accessway is a cost-raiser. The dead end forces mobile equipment carrying heavy loads to slowly back out of the area.

As to the layout of equipment in a process unit, like pieces of equipment should be near each other wherever possible. For example, pumps can be together in a group or in groups and arranged so they can be easily reached and handled. Whenever possible, pumps should be located outdoors and not inside buildings. Outdoors, the pumps can be spotted adjacent to an accessway and out from under low-clearance structures. Located thus, and with clear space provided around each pump, pumps are easy to work on. Replacing an impeller becomes a simple job. Servicing a bearing becomes an easier chore. Complete pumps or pump-motors can be easily picked up by a fork-lift or a crane-car and hauled to the shops.

During turnarounds, work-areas are needed at the process units for the following reasons: to move in and store equipment, materials, and tool trailers before the start of a turnaround; to set down disassembled equipment awaiting cleaning, inspection, or repair; and for work that's more economically done in the field than in a shop.

Thus, each operating area usually needs one or more open work-areas. Sometimes one work-area can serve several process units. All such work-areas should be paved and well-drained.

Process Equipment Design. From a maintenance standpoint, most exchangers should have a removable bundle and be of the pull-through, floatinghead type. A pull-through floatinghead on an exchanger has several distinct advantages. The bundle can be quickly pulled out—no need to unbolt and remove the shell cover or the floatinghead.

After a pull-through tube bundle is cleaned and/or repaired, it can be tested for leaks and then reinstalled in the shell ready to operate—all without removing the floatinghead. A pull-through bundle eliminates the several unboltings and boltings of the floatinghead as well as the in-shell testing of the bundle after it's reinstalled—all required by split-ring, floatinghead designs.

An annular distributor on an exchanger helps maintenance as well as process performance (Figure 2). Since shell nozzles weld to the distributors, nozzle welding doesn't shrink the shell and cause flat spots. With annular distributors, a tube bundle doesn't bind and it doesn't have to be custom-fitted by grinding the cross-baffles. Annular distributors make tube bundles of same-size exchangers truly interchangeable.

Although exchangers may be designed for steam cleaning or chemical cleaning, mechanical cleaning may still be needed. Thus, if heavy fouling is expected, the tube layout and pitch should provide cleaning lanes for rodding and jetting through the tube field.

To facilitate the handling of parts, every exchanger should have lifting lugs permanently attached to any shell cover or channel cover that weighs over, say, 75 pounds. Tapped holes or pulling studs already in the channel-tubesheet, make it easy to attach a pulling plate to the tube bundle. A tapped hole in the floatinghead makes it easy to handle the floatinghead when it is removed.

Piping to heat exchangers should be so spooled that piping connections can be broken loose withoue the handling of long lengths of pipe and heavy valves. All pressure bolting, such as the end flanges, should be through-bolted using bolt studs threaded full length. An exception to this would be the use of stud bolts to keep high-pressure equipment economical.

On bubble columns, ready and easy access to the internals should be provided by external manholes (Figure 3), properly located and adequately sized, and by manways in the trays. If a column is in extremely dirty service, a manhole should be provided at each tray. If the service is clean, manholes may be spaced several trays apart. But, manholes separated by trays should not be more than 30 feet apart to keep the climb-through-tray manways within reason. On tray manways, covers that are removable from either above or below the tray allow

flexibility in the work schedule. Manways should be aligned vertically to simplify the hoisting of parts and tools inside a column. Caps that can be removed by one man working on one side of the tray really speed up column maintenance.

Manholes that are 20 inches or more in diameter allow men adequate crawl room. Hinging the manhole covers instead of swinging them on a bolt or on a makeshift davit, cuts down the size of the maintenance crew. Steel platforms for working should be at each manhole, except when manholes are so closely spaced that several manholes can be reached from one platform.

A well-designed davit is often needed atop a bubble column to handle a heavy relief valve, boxes of bubble caps, tray parts, or maybe just to free more of the mobile equipment during a turnaround. But with a davit or without a davit, the designer should orient the manholes and platforms to provide a clear space for lowering column-parts to grade. Also when clear space is provided at grade-level, mobile equipment can get in and handle the lowered parts.

In the design of fired heaters, provisions should be made for the cleaning and pulling of horizontal tubes. Doors on header housings should be in sections that can be handled easily. When open, these doors should give clear access to all return headers and yet not interfere with the work platforms. Permanent platforms or platform supports for temporary staging should be provided to give ready access to all cleanout-type return bends. Racks nearby for temporarily storing the ground plugs, as they are removed, help insure that each plug goes back into its original seat. Heaters located near the plot edge make access easy and provide added safety. The open area allocated for pulling horizontal tubes should be on the plot so that main roads are not blocked. A heater designed with maintenance in mind will have trolley beams to handle header doors and tube tools.

Much can be gained too by standardization of type and of manufacturer for the equipment widely used throughout a refinery. Take instruments, as an example. For standardization, designers call for the same instrumentation for similar applications and use one manufacturer for each type of instrument. Such standardization considerably simplifies the serv-

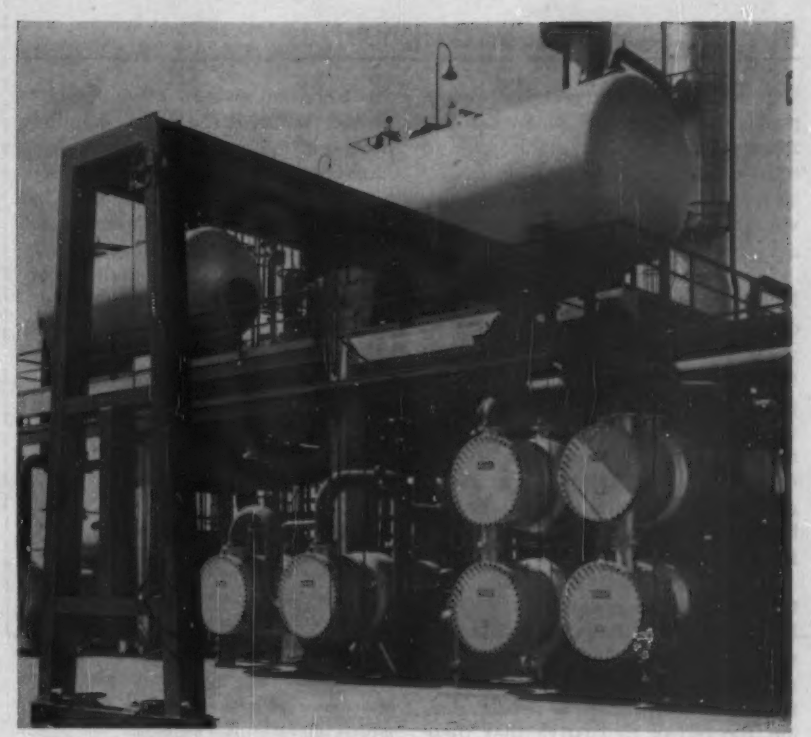


FIGURE 5—A large number of exchangers in a row calls for consideration of a traveling gantry.

FIGURE 6—For handling, a bridge crane should replace the usual monorail over the engine cylinders.

ice, maintenance, and spare-parts problems that usually plague an Instrument Department. It is wise to limit deviations from standardization to those instances where a distinct advantage is realized either in performance or in cost.

One maintenance aid, often overlooked by designers, is the providing of utility stations in the operating areas. These stations can be placed on the structure columns and have proper-sized connections for required utilities such as steam, air, water, electricity. Utility stations should be located so that working areas at grade, up in structures, and in buildings can be reached with no more than, say, 50 feet of hose.

Clearances. In making the detailed layout of a unit, designers should provide minimum clearances around equipment. After clearances are called for, keen watchfulness is needed during detailing to insure that these cleared areas are not obstructed by motor-valves with their bypasses, pipe-supports, piping, structural bracing, and the like. Some of the minimum clearances that should be adhered to are listed in Table 1.

Built-In Handling. Truck cranes and crane-cars have been considerably improved in recent years. Today's mobile equipment for handling has more maneuverability, greater capacity, and longer reach than yesterday's. For example, one crane-car now available can work where the headroom is low, can snake into tight places, and has full-circle swing for its boom. Thus, the trend in modern refineries is to provide more of the mobile-handling units and to cut down on the built-in handling facilities. Before laying out a unit, a designer should find out what mobile equipment the refinery will have available for maintenance handling. However, built-in handling may be called for under certain circumstances. Let's look at some of the cases where built-ins may yet be needed.

TABLE 1
Minimum Clearance Around Equipment

MINIMUM VERTICAL CLEARANCES	
Over main roads	16′–0″
Over secondary roads	12′–0″
Above floors in buildings	7′–6″
Above Elevated platforms	7′–6″
At grade in operating areas	9′–0″
MINIMUM HORIZONTAL CLEARANCES	
Exchangers at grade, shellcover end*	10′–0″
Exchangers at grade, channel end*	5′–0″ + tubebundle length
Exchangers elevated on platforms, either end to handrail	4′–0″
Around exchanger units, aisle between piping	3′–0″
Between shells of adjacent horizontal vessels	4′–0″
Around pumps, aisle between piping	3′–0″
Elevated walkways	3′–0″

* Measured from shell flange.

High exchangers, those with their horizontal centerline more than 40 feet above grade, are usually beyond the capability of a refinery's mobile equipment. Thus, each such elevated exchanger should have a monorail (Figure 4). With a properly designed monorail, the men easily handle the channel cover, channel, tube bundle, and shell cover. At the channel end, the monorail should extend on out over a lowering well. A lowering well allows the tube bundle to be lowered to grade easily and quickly. Provision of walkways on the monorail structure, so that slings can be easily placed on an exchanger bundle, is often overlooked.

Low exchangers, those with their horizontal centerline less than 40 feet above grade, usually are most economically handled by mobile equipment. For maintenance economy, a group of exchangers at grade should be lined up in a row, and a pulling area should be provided adjacent to an accessway or a roadway. A large number of exchangers in a row calls for consideration of a traveling gantry (Figure 5), especially if the exchangers are large and are difficult to handle. A traveling gantry may avoid tying up a crane at the exchanger row for several days. A gantry makes a crane available for other handling often vital to on-schedule completion of a major turnaround.

Large relief-valves, say those with an inlet three inches or larger, are a handling problem when elevated. If a crane cannot easily reach them, a davit or some other suitable means should be provided to pick up the relief valve and lower it to an operating platform or to grade.

Several large compressors in line, found in almost every refinery, require good built-in handling for their maintenance. Often the only handling available consists of two parallel monorails, one over each bank of engine cylinders. And often, the travel along these monorails is blocked by overhead piping, suspended lights, or something else. Such monorails go unused until the maintenance men clear out the obstruction and use the monorails to hang an improvised underslung bridgecrane. Then they can reach more than just the engine cylinders. A bridgecrane can service the compressor cylinders as well as the engine cylinders, and it can handle the intercoolers (Figure 6). At the outset, designers should call for a light underslung bridgecrane for any compressor house containing several large compressors in a line.

Some types of units may warrant more or less special built in handling. For example, the turnarounds of a large catalytic unit often warrant the installation of a pipe-chute for trash, a materials skip-hoist, a vacuum-cleaning system, a passenger-freight elevator of adequate size and speed, and accessways for a large mobile crane. # #

About the Authors

Evans

Bromley

Henry P. Evans, staff consultant for C. F. Braun & Co., has an M.S. degree in engineering, and has been with the Bureau of Reclamation as design engineer and regional engineer. He joined Braun in 1947 and has been a civil engineering consultant since that time. He has a wide experience in the petroleum refining field and has been active in studies of refinery maintenance.

Ditmas Bromly, chairman of the staff consultants for C. F. Braun & Co., Alhambra, Calif., has a B.S. degree in engineering. Prior to joining Braun in 1929, he was with Union Oil Co. of California and the Southern California Edison Co. He has extensive experience in all phases of engineering in the petroleum industry, and has been in charge of some fifty maintenance studies for refineries, chemical plants, and others.

Upgrade Your Maintenance Personnel

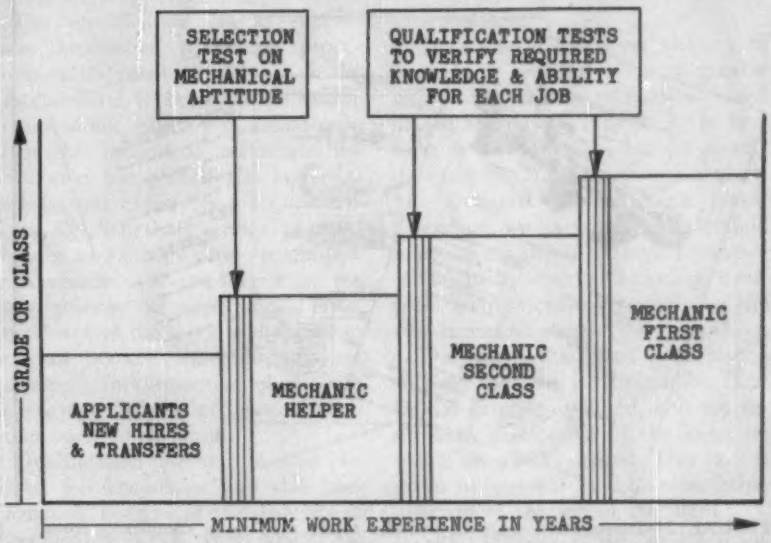

SELECTION TEST ON MECHANICAL APTITUDE
QUALIFICATION TESTS TO VERIFY REQUIRED KNOWLEDGE & ABILITY FOR EACH JOB
GRADE OR CLASS
APPLICANTS NEW HIRES & TRANSFERS
MECHANIC HELPER
MECHANIC SECOND CLASS
MECHANIC FIRST CLASS
MINIMUM WORK EXPERIENCE IN YEARS

FIGURE 1—Before advancing to higher levels, each mechanic qualifies himself under a systematic upgrading procedure.

Select, train and upgrade your maintenance wage roll personnel and insure operational continuity.

G. O. Pitts and L. H. O'Donnell
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RELIABILITY of individual components is now a key to continuity of operations in today's highly instrumented, integrated plant. Failure of one small unit in a process can shut down all production. Success or failure of the individual units often depends upon the degree of competence and the skill of the individual maintenance mechanic on the job.

The change in magnitude and complexity of the maintenance problems which has taken place in less than 20 years is a real measure of the challenge of the future. Better planning of maintenance activities, improved equipment design, and similar programs are of real importance in this picture of the future. Also of importance is the selection, training, and upgrading of the individual men who will perform the maintenance tasks that are vital to assure high quality, quantity production.

One way the Du Pont Company is meeting this challenge for maintenance wage roll personnel development is described in detail in this article.

Careful selection, directed training, and systematic upgrading are the essential ingredients of an effective program for development of maintenance wage roll personnel. Such a program is essential for the protection of plant investment today when the responsibility for operational continuity is shifting from production toward maintenance personnel.

Development Program. The overall program for development of a maintenance mechanic is illustrated in Figure 1.

In broad terms, the program operates as follows: Before admitting an applicant to the maintenance wage roll force, the plant screens the individual by a specific selection procedure. While in the position of helper, and at each subsequent level, the mechanic receives both formal and on-the-job instruction in those maintenance job tasks which are pertinent to the plant's requirements. Before advancing to higher levels, each mechanic qualifies himself under a systematic upgrading procedure by demonstrating job knowledge and ability to perform the work.

Many plants have found this organized program, when established prior to the start-up of new facilities, of major value in obtaining the full co-operation of the new employes.

Selection. Procedures for the selection of applicants, of course, include some general criteria of aptitude for industrial maintenance work.

Training, whether formal or on-the-job, does not take hold on barren ground. It must start with men who have the capacity to acquire the necessary competence.

In selecting applicants for maintenance mechanics, it is imperative that the general wage-roll qualifications, such as age, character references, physical ability, and the like, be followed. In addition, the maintenance mechanic applicant must possess a high level of ability to reason

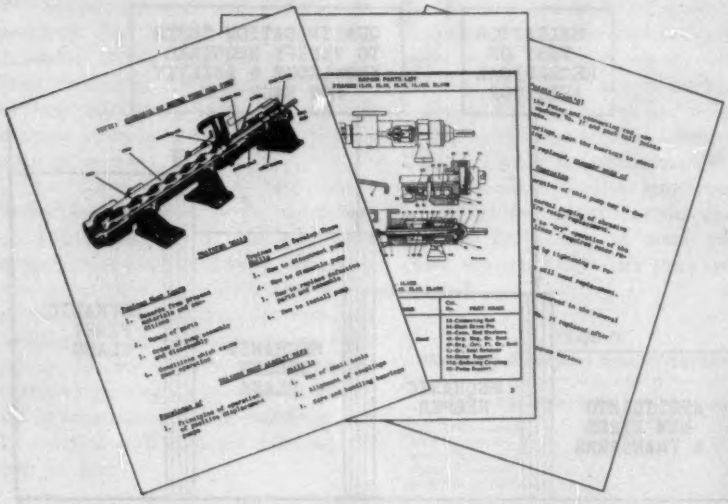

FIGURE 2—Instructional material includes topics ranging in complexity from installation of roller bearings to precision surface grinding practices.

MAINTENANCE MECHANIC QUALIFICATION TEST QUESTIONS:

SKILL: Pipefitting CLASS: _____ GROUP: Materials TYPE: T/F

0221201

T F The schedule number of pipe refers to its wall thickness or strength.

0221202

T F The outside diameter of 1/2" schedule 40 pipe is the same as the outside diameter of 1/2" schedule 80 pipe.

0221203

T F Extra strong weight steel pipe is the same as schedule 80.

0221204

T F A short nipple is not as strong as a close nipple.

0221205

T F A short nipple is the same length as a close nipple.

0221206

T F Soil pipe is commonly used for steam and condensate piping.

0221207

T F The series number of a flange refers to its pressure rating.

0221208

T F Check valves are installed to prevent reversal of flow in piping.

0221209

T F Gate valves permit closer regulation of flow than globe valves.

0221210

T F When steel valves for high-pressure service are stamped with two pressure ratings, the higher pressure rating applies to steam service.

0221211

T F In a low-pressure lubricating oil line Neoprene is superior to rubber as a gasket material.

FIGURE 3—This sample shows just one test given to pipefitters.

mechanically, and a means should be provided to determine this. Without this important and special qualification, the average individual lacks the ability to be economically developed and is capable of doing only routine maintenance work. Since the major part of the maintenance work to be done in the complex industrial plant of today is not routine, the man who lacks the ability to reason mechanically is restricted in his type of work, his progression, and his usefulness to the organization.

If applicants are to be hired directly for positions above that of helper, they must demonstrate, through an objective check, that they possess the required skill knowledge and performance ability. This objective check is devised from a library of skill knowledge questions and skill performance tasks. In this manner, these applicants can be placed at a level consistent with their experience and abilities and also consistent with the requirements of the maintenance tasks on the plant.

Thus the selection practices are designed to obtain men who have the capacity to acquire the necessary competence to progress to the top wage roll level in the maintenance organization. Having selected men on this basis, our next step is to provide the opportunities to learn the wide variety of complex skills needed for effective performance on the job.

Training. An age-old axiom in industry is that "training is the responsibility of line supervision." When we attempt to apply that axiom to the normal practical plant situation, we experience difficulties because of the limited teaching ability of line supervision. However, in du Pont, we have found a successful method of using the valuable technical know-how of the supervisor in the essential training activity.

The success of our maintenance wage roll training effort stems from two main factors: the unique organization of instructional material into easily administered lesson units, plus high-quality presentation of the material. Both of these factors are critical to effective and efficient accomplishment of training in the highly diversified field of maintenance skills.

The lesson unit form of instructional material is illustrated in Figure 2. This is one sample of the more than 400 units which have been prepared to cover a wide variety of topics. These topics range in complexity from installation of roller bearings to precision surface grinding practices.

Each topic is independent and complete in itself, with specific training goals stated, organized in good teaching order. Each is designed for an instruction period of not more than two hours' duration.

The material is prepared by men experienced in both engineered plant maintenance and industrial training activities. The specific intent is to place in the hands of line supervision in the plant, maintenance information in practical training form for everyday use. The time required for advance preparation for training sessions is minimized for plant instructors, and training activities can be readily scheduled with little advance planning. With this type of material, each unit and group within a large plant maintenance organization can be very selective in arranging material to fit their specific maintenance training needs. In the same manner, instructional material is readily arranged to fit each level in the plan of progression from helper through "top" mechanic.

High-quality presentation of the training material is an obvious requirement when organized training activities are conducted on plant time. Without high-quality presentation, this type of training has little economic justification. In order to meet this economic requirement, the instructor must know his subject and must be competent in the use of effective instructional techniques. Line supervision, for the most part, do meet the first instructor requirement for knowledge of the subject; seldom do they possess instructional skill. For this reason, a separate Instructor Training Course for line supervision

is an integral part of maintenance wage roll training activities.

The course in instructional techniques is forty hours in length, presented over a two-week period. It is aimed at techniques found to be effective in training of wage roll personnel and consists of such items as:

- Instructor attitudes
- Student similarities
- Motivation in training
- Analysis of material
- Use of visual aids
- Active participation
- Informal evaluation
- Use of progress tests

The success of this course can be measured only in terms of skill in application of the principles and techniques. In order to develop this skill, each participant is given extensive opportunity to lead practice training sessions during the two-week period. In this manner each participant obtains a thorough understanding of the meaning and importance of the principles which apply to the practical training situation, and each participant recognizes that he can effectively discharge his often unstated responsibility for training.

It is not our intent to minimize the importance of the principle that the instructor must know the subject before he can train his men with this material. This is a very important requirement and can result in assigning an instructor who is not the line supervisor to conduct the course. This is particularly true for many complex topics, such as those dealing with optical alignment, instrumentation, mechanical seals, and precision welding. Wherever practical, however, we have found it desirable for the line supervisor to conduct the training activities for his men.

After selecting men who possess the capacity to reach a high level of competence in maintenance work and providing opportunities for learning the tasks involved, the next requirement is to provide reliable incentive to learn and progress.

Upgrading. Realistic promotion for maintenance wage roll personnel must include objective indicators of job knowledge and skills.

Careful selection and directed training lose much of their value if promotion is based solely on seniority and "staying out of trouble." A high level of personal incentive to learn and to continuously improve job skills is obtained by including qualification checks in the upgrading procedures for maintenance wage roll personnel.

The qualification checks supplement established promotion procedures on the plant. Experience on the job continues to be a critical factor in promotion, but is considered only after the individual candidate for promotion has passed the impartial and factual check on his qualifications. Age, length of service, physical abilities, and other existing promotion requirements are considered in the same manner as experience. Thus, knowledge of the work and ability to perform become an undisputed requirement for promotion along with experience, length of service, and other essential elements.

Qualification checks consist of two parts; job knowledge and skill performance. Because of the diversity of maintenance work assignments, we have found it essential to prepare an extensive library of questions for this purpose. A sample of some of the questions on job knowledge which exist in this library is shown in Figure 3. We identify these questions in the library by four factors: skill represented, degree of difficulty, subject grouping, and type.

You will note that the questions shown in Figure 3 involve pipefitting materials and are of the true-false type. The class, or degree of complexity, has been left blank in this example because this is a matter of personal judgment based on plant experience.

From this library the specific job knowledge qualification checks are prepared. Each check is carefully compiled to insure that the questions accurately reflect the practical job knowledge required for promotion to the designated step in the line of progression.

Qualification based on ability to perform is perhaps of even greater importance than qualification based on job knowledge. This ability to perform is demonstrated by the candidate for upgrading on an actual plant job arranged as a "check task." Therefore, we have prepared detailed material for use in skill performance qualification checks, including complete instructions for conducting the checks and an objective scoring sheet.

The instruction sheet is furnished to the candidate for promotion. The task is carefully defined, and the individual is informed of the items on which he will be scored. This task is given to him just as if he were being assigned to the job in the plant.

The examiner instructions for the performance check specify the procedures to be followed in directing the performance of the task. The examiner is also given a score sheet which is to be used to grade each of the elements which are essential to performance. The relative weight of each element is indicated by numerals on the sheet.

These qualification checks, both job knowledge and skill performance, provide an objective measure of the candidate's qualifications for promotion. They are used within the framework of any existing lines of progression. In every situation, they provide an equitable basis for promotion by recognizing ability, as well as provide an incentive for the individual mechanic to continuously increase his job knowledge and skills.

About the Authors

Pitts

O'Donnell

George O. Pitts is a consultant supervisor for E. I. du Pont de Nemours & Company, Wilmington, Del., where he supervises activities of maintenance engineering consultants. Pitts graduated in 1939 from the University of Missouri School of Mines with a B.S. degree in mechanical engineering. Shortly after graduation he joined Newport News Shipbuilding & Drydock Co., where he remained until joining Du Pont in 1945.

L. H. O'Donnell is senior service engineer for E. I. du Pont de Nemours & Company, Wilmington, Del. In this position he provides consulting assistance to company plants on maintenance personnel development activities. O'Donnell graduated from the University of Missouri in 1942 with a B.S. degree in chemical engineering. Prior to joining Du Pont, O'Donnell was plant engineer in the hospital division of the Veterans Administration; an instructor in engineering for the naval reserve training center; and an engineering officer in the Navy.

FIGURE 1—Dimensional data from 5730 drawings make up this model of a typical refining unit.

Models, a New Maintenance Tool

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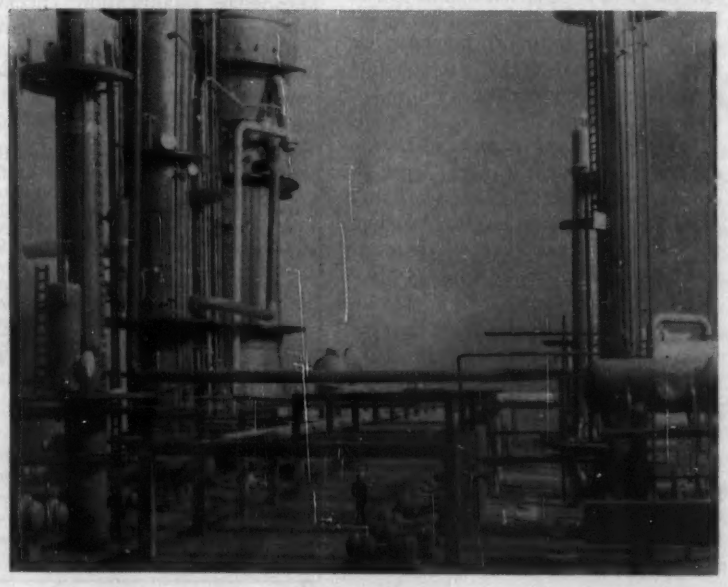
FIGURE 2—Eye-level view shows clearances provided for maintenance.



The scale model provides an ideal ground for understanding between maintenance and design personnel. Troublesome arrangements are quickly spotted, and improvements suddenly become obvious.

THE GROWING use of scale models in plant design brings to the processing industry a new tool for cutting plant maintenance costs. Exploiting the possibilities of scale models can benefit two important aspects of maintenance work. They are:

- Planned maintenance operations.
- Communications—top to bottom and bottom to top.

These two aspects of maintenance are dependent upon a thorough understanding and visualization of all parts of the unit or plant, and the three dimensional model provides the means to demonstrate, to all concerned, the location of an operation, its scope and its relation to the surrounding areas. This can be done quickly and effectively with a scale model and without resort to files of drawings or sketch making.

Planning During Layout. Planning for maintenance properly begins with the original layout and design of the unit, long before the plant site is cleared for construction.

Maintenance planning at this time can be most effective. When the unit is first being arranged, it is important to bring together those responsible for maintenance, safety and design. Unfortunately, this is seldom done. The problems of maintenance do not appear immediate and they are poorly defined. Much time must be spent by all parties studying preliminary drawings and specifications to become even partially familiar with the arrangement. There is seldom time allowed in design schedules for such study and the layout is in a constant state of change. As a result, such early discussions are apt to be attended with insufficient interest and understanding, if at all. Yet, management attention continues to be directed toward rising costs of maintenance. We cannot afford to wait until after the plant has been erected to discover what has or has not been planned with respect to maintenance. Ways and means to increase the efficiency of maintenance operations can and must start with the arrangement of equipment and the layout and type of service and handling facilities. Better planning then will save manhours, increase safety and shorten downtime throughout the useful life of the plant.

It is not simple, even for the practiced, to build up the necessary mental image of spatial relationships in a modern, complex plant. Steel framing plans, piping positions, equipment details, handling facilities, platforms, clearance and access areas, trucking lanes and innumerable other important and related considerations must be gradually assimilated by reference to literally hundreds of sketches and drawings for even a small unit. The model does away with this background work. It shows clearly the true relationship of one part to another. It facilitates discussion and speeds understanding by eliminating the need to repeatedly go through piles of blueprints looking for dimensions, clearances and references (Figure 1). Troublesome arrangements are quickly spotted, and improvements suddenly become obvious. Lowering vessel internals to grade, pulling an exchanger bundle or easing out a heavy relief valve become live operations instead of static notations on a drawing or specification.

Naturally, when various interests are gathered to discuss overlapping problems, the degree of emphasis on specific points will vary directly with each individual's responsibility and experience. These differences must be moderated and compromised to provide the best possible solution within the limitations of cost and schedule. The scale model provides an ideal channel for mutual understanding and results in decisions which are made faster and with greater conviction.

The contributions made by maintenance groups at a design model conference will pay off in large dividends. Their opinions are of material

FIGURE 3—Maximum use of mobile equipment has been planned for this large exchanger bank.

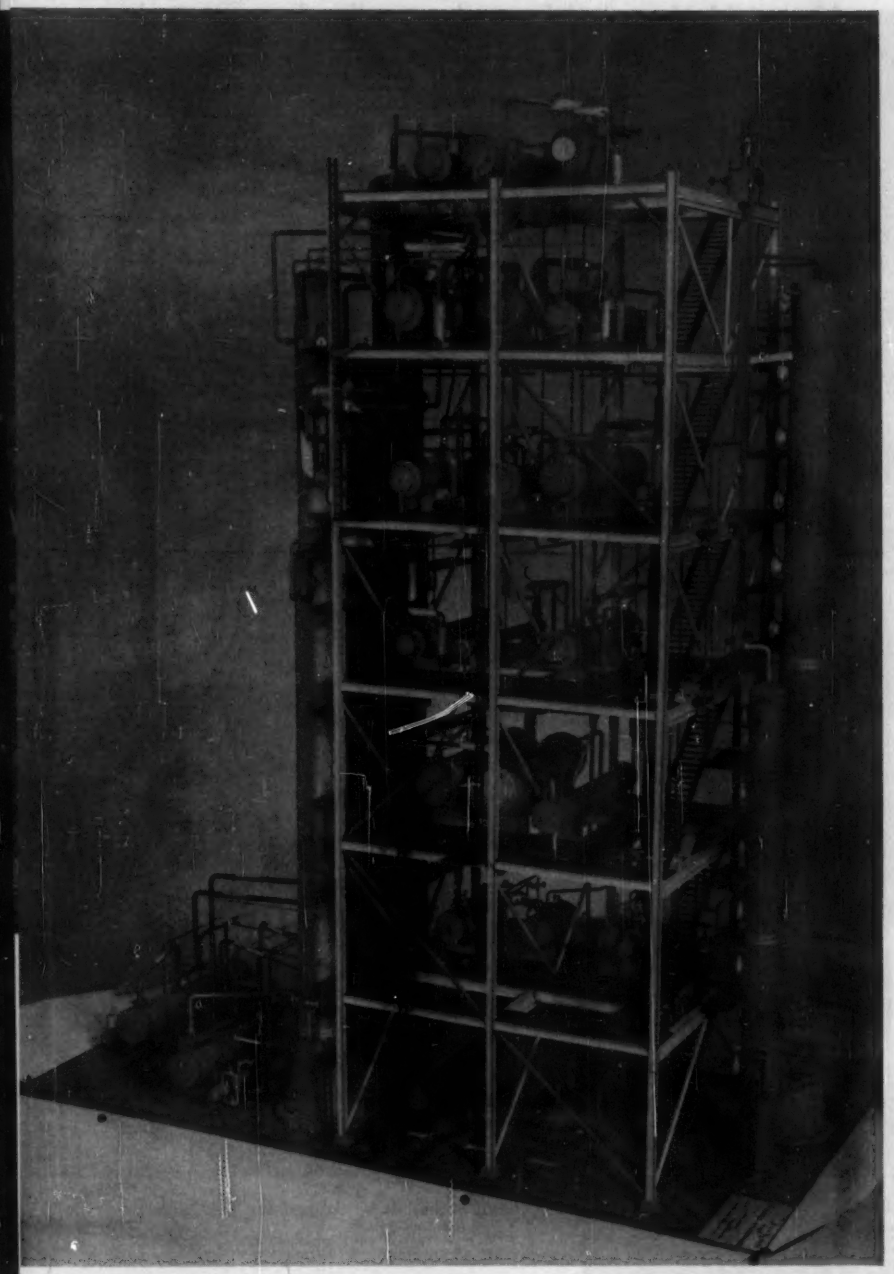


FIGURE 4—Adequate platforming is provided as a result of critically viewing an earlier design of the model.

assistance in evaluating, for example, refinery traffic, both for routine maintenance and for a typical unit turnaround. Questions can be raised and discussed involving mobile tool clearances and dimensions, complicated lifts in congested areas, location of stockpiles, temporary toolrooms and workshops and movements of personnel (Figure 2).

Location of permanent handling facilities such as booms and trolleys can be examined to assure maximum use and minimum interference with a corresponding saving in field time in the future. Overhead cranes and gantry cranes at grade can be evaluated against mobile equipment for the specific installation shown on the model (Figure 3).

Elevated working platforms for refinery personnel are always a subject of interest and frequent controversy among the various elements influencing the detailed arrangement of a unit. While specifications reflect the general refinery policy with regard to degree of required access to equipment for operation and maintenance, it is impossible to define in words all situations. Much time has been spent on discussions centered about the interpretation of specifications because the specific situation itself has not been clearly understood from the drawings.

The problem of platforms first confronts designers. For normal operating conditions, considerations of economy, the position of access stairs or ladders, vertical and horizontal clearances, structural strengths, location of pipe and pipe supports, and details of vessel internals all build up a strong case for access platforms of minimum practical size. Maintenance must present its case quickly and forcefully during the formative design stage for platforms which are adequate for personnel, materials and tools of the various crafts using them during busy turnaround periods, or be prepared to accept the platforms furnished. The design model makes it practical for design and maintenance people to quickly review each platform for specific conditions of expected use (Figure 4). The relative merits of permanent access platforms can be compared to temporary staging for cost and practicability.

Tall structures in particular, such as those required for fluid coking and catalytic cracking units, can be more intelligently planned with the aid of a model. These units usually undergo major internal inspection and repair at turnaround periods. Space on elevated platforms should be provided for temporary storage of scaffolding materials, and for welding machines around and about vessel manholes. Although maintenance can furnish such foresight, it is effective only if properly presented before the demands of schedules freeze the design. A scale model, presenting each stage of the design from its inception can be used very effectively to supplement argument and to demonstrate, if necessary, the most feasible design.

Planning During Operation. Scale models offer exceptional possibilities for planning maintenance after the unit is put on stream. This is the generally accepted phase of planned maintenance which is widely practiced to effect savings by improved procedures governing routine maintenance and down periods.

When used in advance of a scheduled shut-down, the model can be used to develop a step-by-step schedule of anticipated operations to be carried out during the down period.

The effective disposition of labor forces, equipment and materials can be studied in detail without the interruption and time loss caused by having to gather information on location and clearances from several drawings.

The model can be readily used to note test and safety blinds which must be installed and to check off orifice or other instruments to be inspected or replaced.

The problems of craft integration, temporary storage facilities, scaffolding requirements and complicated lifts can be discussed at the model with those involved and costly oversights or possible trouble areas spotted for particular attention.

The presence of the model at such discussions acts as a catalyst, encouraging a free exchange of opinion. The suggestions of craft foremen and other specialists are more readily offered and understood. The acceptance or rejection of an idea by the Planning group is greatly speeded, since the model shows all parts of the plant in true relationship.

Consider these savings: Instead of sending the carpenter foreman to the location, as in the past, to see the kind and extent of platforming required to do a certain job, reference can be made to the model right there in the office and a decision made immediately. Crafts necessary to do particular jobs where jurisdiction is in doubt may be decided by reference to the model, right at the planning table. Necessity for temporary supports or shoring is clearly pointed up with all major lines represented accurately to scale. In discussing heavy lifts, the model serves as a reference tool upon which all stages of the handling can be vividly demonstrated. Where maintenance groups are charged with the responsibility for planning alterations or expansions to existing facilities, the model again saves the time and energy of a busy staff. By illustrating the feasibility of one plan or another, the best solution can be reached quickly and by using the model to define the scope of the projected work alternate possibilities can be more easily compared for cost. Crossovers and tie-ins can be located in the best spot by checking them against the model.

Many other uses for the model will suggest themselves, when changes are being planned. Among them are: the choice of location for bulk material storage and temporary tool rooms, the routing of mobile equipment such as crawler cranes, the location of gin poles and guy wires, anchor points for drum hoists, accessibility to hitch points, etc. By planning these things on the model, interferences, temporary dismantling and traffic obstruction will be minimized. The results are: fewer steps, less time, less confusion and less cost.

Contract Maintenance. The use of a scale model for maintenance planning is especially beneficial when outside help must be called in. In these cases, the scope of the intended work is explained fully and clearly much faster than can possibly be done in any other manner. Better estimates of manhours and calendar schedules are developed in less time, and the orientation period for new personnel will be drastically reduced, resulting in intelligent help during the period which would otherwise be necessary to "become familiar" with the plant.

When additions or alterations are to be made to the plant by an outside contractor, the model again serves to define the job. The extent of the work is better explained and understood and better estimates and schedules can be established. Discussions around the model, with the contractor present, can lead to ideas that will reduce downtime for making tie-ins and will help to avert interference with normal operation.

Emergency Maintenance. Despite the best of precautions, there does arise at one time or another a situation which requires immediate action. Then, carefully prepared procedure is abandoned temporarily to meet sudden and unexpected developments.

The successful handling of such a situation depends to a great extent upon good communications. This is particularly true when a number of individuals are to be directed toward a specific task in a limited time.

In an emergency, by reference to the model, the plan of work can be expedited through visual demonstration to craft foremen, saving time and preventing confusion in orders. Directly in consultation with the craftsmen, work orders may be drawn up to cover the situation.

Thus, the scale model can be put to use to serve maintenance when the plant is conceived, while it is operating, during turnarounds, alterations and until the plant is ultimately replaced—see for yourself—on the model.

About the Authors

Kershaw

Hollowell

Harold Kershaw has been instrumental in developing The M. W. Kellogg Company's model program as a practical aid to design. He joined Kellogg in 1939 as a piping designer, and supervised the development of a method for the handling of heat-exchanger bundles. He is co-holder of patents on Kellogg's plug valve for the Orthoflow FCC process.

In 1949, Kershaw organized the plant-layout section at Kellogg, and was section head of that group until recently. During that time he developed Kellogg's in-line plot layout used in many refineries today.

A. F. Hollowell has been with The M. W. Kellogg Co. since 1945 and has worked in the design engineering, process engineering, economics and plant operation sections. He has acted as Kellogg's trouble shooter at turnarounds and shut downs in refineries. He is at present a member of Kellogg's offsites group, dealing with product handling and shipping, tankage and wastes disposal. Hollowell is a graduate of the Cooper Union School of Engineering with a B.S. degree in chemical engineering. He is a licensed professional engineer in New York.

Flow Sheet Plans Your Shutdown

F. D. Macy,
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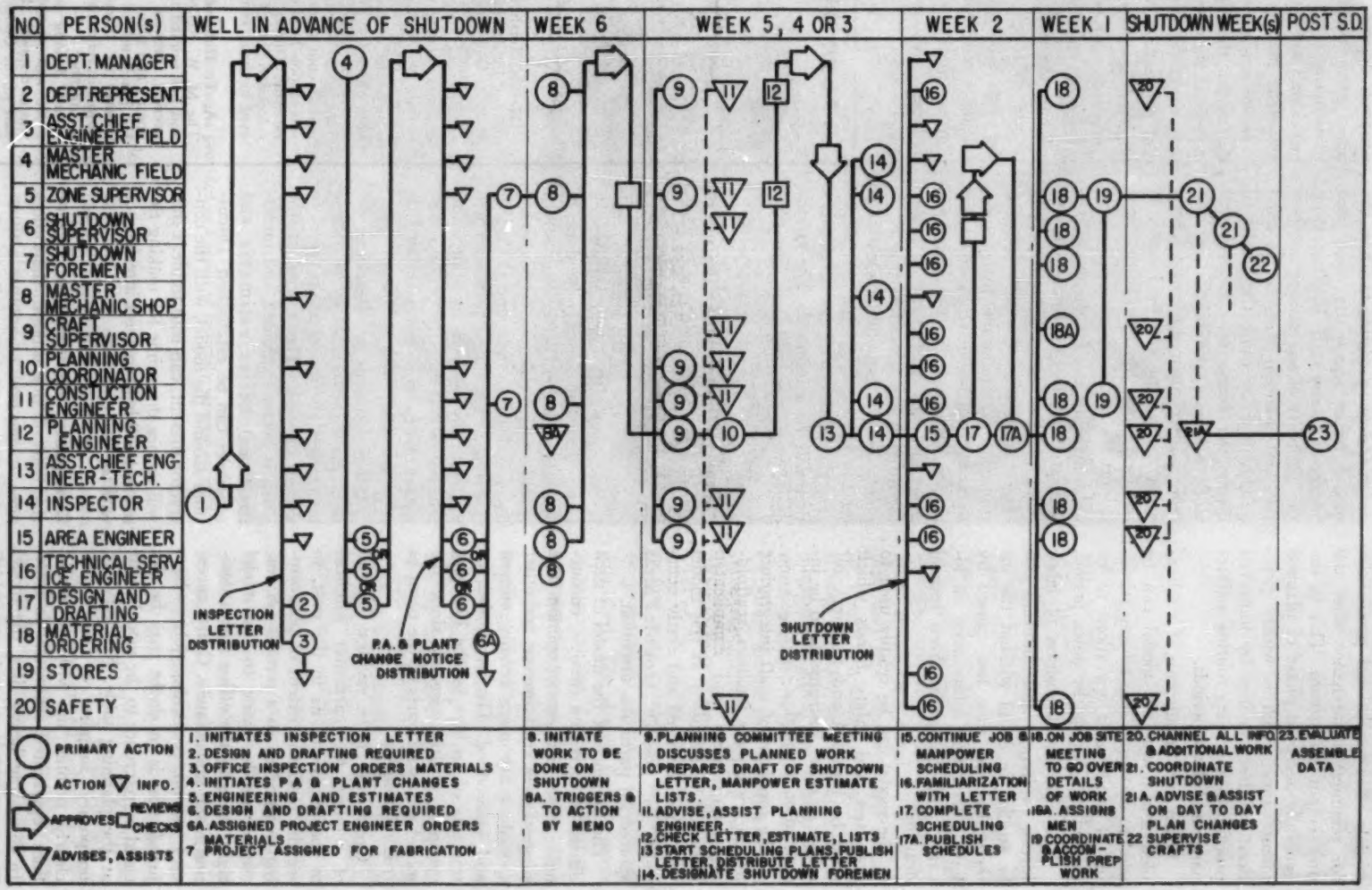
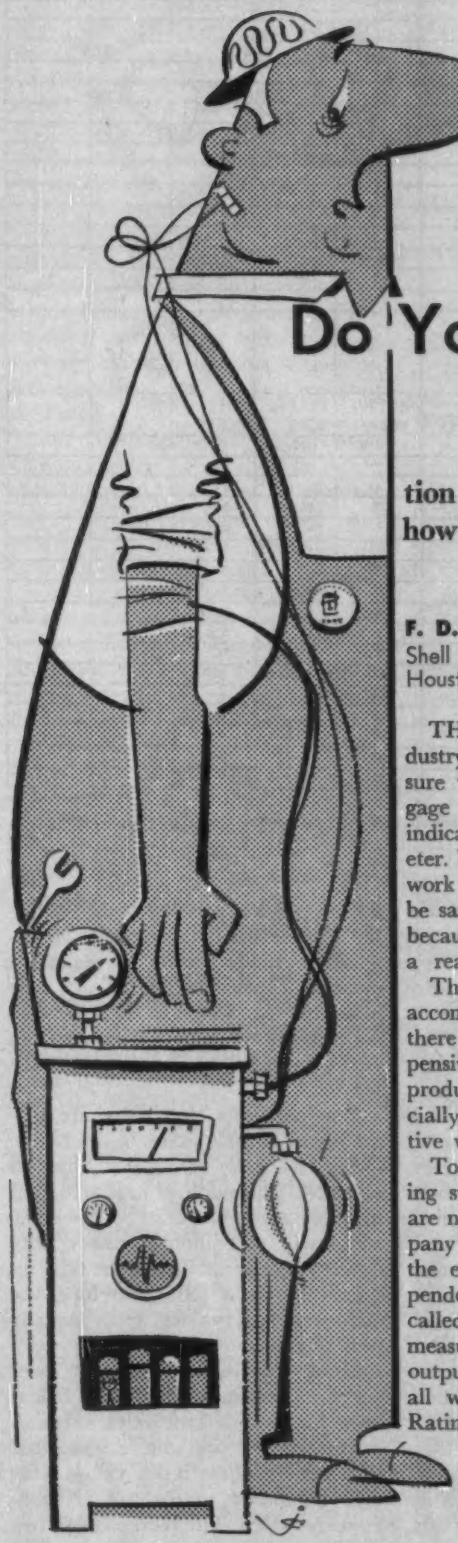
Here's a check on your planning program. See if your plant measures up to this degree of preparation.


NO.
PERSON(s)
WELL IN ADVANCE OF SHUTDOWN
WEEK 6
WEEK 5, 4 OR 3
WEEK 2
WEEK 1
SHUTDOWN WEEK(s)
POST S.D.
1 DEPT. MANAGER
2 DEPT. REPRESENT.
3 ASST. CHIEF ENGINEER FIELD
4 MASTER MECHANIC FIELD
5 ZONE SUPERVISOR
6 SHUTDOWN SUPERVISOR
7 SHUTDOWN FOREMEN
8 MASTER MECHANIC SHOP
9 CRAFT SUPERVISOR
10 PLANNING COORDINATOR
11 CONSTUCTION ENGINEER
12 PLANNING ENGINEER
13 ASST. CHIEF ENGINEER - TECH.
14 INSPECTOR
15 AREA ENGINEER
16 TECHNICAL SERVICE ENGINEER
17 DESIGN AND DRAFTING
18 MATERIAL ORDERING
19 STORES
20 SAFETY
INSPECTION LETTER DISTRIBUTION
P.A. & PLANT CHANGE NOTICE DISTRIBUTION
SHUTDOWN LETTER DISTRIBUTION
PRIMARY ACTION
ACTION
INFO.
APPROVES
REVIEWS
CHECKS
ADVISES, ASSISTS
1. INITIATES INSPECTION LETTER
2. DESIGN AND DRAFTING REQUIRED
3. OFFICE INSPECTION ORDERS MATERIALS
4. INITIATES P A & PLANT CHANGES
5. ENGINEERING AND ESTIMATES
6. DESIGN AND DRAFTING REQUIRED
6A. ASSIGNED PROJECT ENGINEER ORDERS MATERIALS
7 PROJECT ASSIGNED FOR FABRICATION
8. INITIATE WORK TO BE DONE ON SHUTDOWN
8A. TRIGGERS & TO ACTION BY MEMO
9. PLANNING COMMITTEE MEETING DISCUSSES PLANNED WORK
10. PREPARES DRAFT OF SHUTDOWN LETTER, MANPOWER ESTIMATE LISTS.
11. ADVISE, ASSIST PLANNING ENGINEER
12. CHECK LETTER, ESTIMATE, LISTS
13 START SCHEDULING PLANS, PUBLISH LETTER, DISTRIBUTE LETTER
14. DESIGNATE SHUTDOWN FOREMEN
15. CONTINUE JOB & MANPOWER SCHEDULING
16. FAMILIARIZATION WITH LETTER
17. COMPLETE SCHEDULING
17A. PUBLISH SCHEDULES
18. ON JOB SITE MEETING TO GO OVER DETAILS OF WORK
18A. ASSIGNS MEN
19 COORDINATE & ACCOMPLISH PREP WORK
20. CHANNEL ALL INFO. & ADDITIONAL WORK
21. COORDINATE SHUTDOWN
21A. ADVISE & ASSIST ON DAY TO DAY PLAN CHANGES
22 SUPERVISE CRAFTS
23. EVALUATE ASSEMBLE DATA



Do You Need a Labor-Meter?

If you can measure everything from acceleration to zigzag, why not measure labor performance? Here's how Shell does it.

F. D. Macy
Shell Oil Company
Houston

THE PETROLEUM refining industry takes for granted that pressure will be indicated by a pressure gage and that temperature will be indicated by some kind of thermometer. Yet, when it comes to measuring work accomplishment we have had to be satisfied that everything went well because we "felt" that way. We lacked a real measure of accomplishment.

This can be understood since work accomplishment involves people and there has been no easy, short, inexpensive method for measuring the productivity of people. This is especially true on long cycle, nonrepetitive work.

To fill this apparent void, two rating systems were devised, tested and are now in use at the Shell Oil Company Houston refinery. One measures the effectiveness of labor output expended on a unit shutdown. This is called the HODIG Rating. The other measures the effectiveness of labor output among the respective crafts on all work. This is called the COIN Rating.

HODIG. Although recognizing the need for some indicator to establish the output of labor expended on a unit shutdown, previous attempts have been futile because of the many variables that exist in a maintenance shutdown. Some of these variables involve types of equipment, unit layout, and job complexity. These variables and others have made it difficult to compare the work performance on different units. In addition, the shifting work load, during each shutdown, has made comparisons of shutdowns on the same unit difficult.

In an effort to provide a sound foundation for comparison, an extensive study was made of shutdown work. This study included three methods of work measurement. Actual job observations were made in a number of cases. This approach is necessary but time-consuming. To supplement this information, a series of spot observations were made using the work sampling technique. The other data were tabulated and analyzed from accounting records.

To accumulate fair and representative data, records were studied on approximately one hundred unit shutdowns. These data covered a five-year period and represented eighteen operating units.

In spite of the feeling that no two

MAINTENANCE–Do You Need a Labor-Meter? . . .

UNIT		COLUMNS				VESSELS			EXCHANGERS				PUMPS	
		CLEAN	INSPECT	REPAIR MINOR	REPAIR MAJOR	CLEAN	INSPECT	REPAIR	CLEAN	INSPECT	BUNDLE RENEW	BUNDLE RETUBE	CHECK	REPAIR
CRUDE	1	40	50	105	325	20	25	45	25	30	15	75	30	90
	2	40	50	105	325				25	30				
	3	20	40	105	325				25	30				
	4	40	160	105	600				40	60				
CRACK	1	80	90	105	325		PER		40	60	PER		PER	
	2	80	90	105	600				40	60				
	3	100	120	105	600		VESSEL		40	80	BUNDLE		PUMP	
GAS	1	20	60	105	325				25	30				
	2	20	60	105	325				25	30				
	3	40	120	105	325				40	60				
	4	40	160	105	600				40	60				
TREAT	1	40	60	105	325				25	40				
LUBE	1	60	80	105	600				25	40				
	2	60	80	105	325				25	40				
	3	60	80	105	325				25	40				
	4	60	80	105	325				25	40				
	5	60	80	105	325				25	40				

		FURNACES				DRIVES	POP VALVES	PIPING		INSTRU. WORK	ELECT. WORK	PREP. & CLEAN		
		CLEAN	REPAIR	RETUBE	PAINT			RENEW	GEN. WK.					
CRUDE	1	175	50	25	50	40	10	25	32 %	7 %	1%	5%		
	2	175	50			40		25	32	7	1	5		
	3	120	50			40		25	32	7	1	5		
	4	120	50	PER	PER	40	PER	50	28	7	1	5		
CRACK	1	140	100			40		50	23	11	1	5		
	2	250	125			40		50	23	7	1	5		
	3	250	100	TUBE	FURN.	40	VALVE	50	26	7	1	5		
GAS	1	60	25			40		25	35	9	1	5		
	2	60	25			40		25	35	9	1	5		
	3					40		25	35	9	1	5		
	4	120	125			40		25	29	9	1	5		
TREAT	1					40		25	35	11	1	5		
LUBE	1	120	50			40		40	23	11	1	5		
	2	120	100			40		40	26	9	1	5		
	3	120	50			40		40	26	9	1	5		
	4	120	50			40		40	35	9	1	5		
	5	120	50			40		40	35	9	1	5		

FIGURE 1—These job standard values are theoretical man hours required to complete the job, corrected by a productivity factor.

shutdowns are alike, the majority of shutdown work is routine. Work is done on vessels, exchangers, furnaces, pumps, in fact, every type of refinery equipment. If this is not true, it is not a representative shutdown. But what is routine?

In the case of a fractionating column, we isolate and clean. If there is to be an entry, we blind or blank off entirely, gas free, and remove manways. If there is to be an internal inspection, the inspection plates on each tray are removed, if necessary. Finally, of course, the plates are reassembled, the manways replaced, and the blinds removed.

Similarly, on exchanger work, the heads are removed, the bundle may or may not be pulled, the tubes and shell are cleaned, and the exchanger is reassembled and tested. Thus, it is possible to separate the work involved during a shutdown into several categories.

The analysis involved itemizing the man hours spent on each type of equipment, in each category. From this analysis, a value expressed in man hours was determined for each item, where applicable and distinguishable. In determining the values, the standard deviations were calculated and used as a measure of dispersion of the data. In those categories of a general nature such as general clean up or general piping work, the 'line of best fit' was calculated and data applied on a unit basis.

Once these values were determined from historical records, they were then adjusted by the data obtained from job observations and work sampling. The final result was a tabulation of standard values, which, when applied to each shutdown, would be an indication of the work load.

This tabulation was compiled in the form of a reference table as shown in Figure 1. The right hand column lists the respective process units. Across the top are listed the types of equipment and the categories or breakdown of activities which apply to each type of equipment. Listed in the appropriate cells are the standard values from which a work load index can be calculated.

You will note that there are separate and distinct values in most cells. Other cells have values that apply to all units. The findings indicated that in many cases the unit, unit service, and brand of equipment made little difference in variability of the time required to do a job. Therefore, the same standard values apply equally well to all.

Using this index tabulation, over one hundred shutdowns were calculated for a work load index value. A calculation for one unit is illustrated in Table 1. These index values were then compared to the actual man-hours recorded. The ratio of these two

figures gives the "HODIG Rating" for each shutdown. For instance, on one shutdown, of a Gas Plant Unit the actual manhours reported were 5207. The calculated workload index was 3,008. The resulting "HODIG Rating" was 60. Again on a cracking unit, the actual manhours expended were 15,124; the workload index was 7228 with a resulting HODIG of 48.

The index values were then tested for significance and validity.

First, a correlation was calculated between the actual manhours expended on each shutdown and the respective workload index. Over one hundred samples were available. The resulting coefficient of correlation was very significant, indicating a close relationship between the two columns of data.

Second, an analysis of variance was made using the same data. The results showed again that the relationship was very significant and could have occurred, by chance, less than one time out of one thousand.

With such significance, there was no hesitancy in introducing the index as an indicator of the workload for shutdown work and in using it to determine the effectiveness of shutdown planning and execution.

What should we call this "rating?" Since the standard values inherently contained many of the shortcomings of past practices and historical records, they could not indicate "efficiency" in the strictest sense. Also, the usual reaction to an efficiency report is immediate resistance. If this rating was to be accepted and still offer a form of constructive criticism, the name should be attractive yet expressive. We recalled that after many shutdowns the question was asked "How did it go?" Now we can answer with the "HODIG".

After every shutdown, once the necessary data have been reported and collected a "HODIG" report is issued. It is a simple report giving only the following information:

- Unit and Dates of Shutdown
- Downtime Hours (Stream to Stream)
- Labor Costs
- Labor Hours
- Workload Index
- HODIG Rating
- Previous Average HODIG (Number of Shutdowns Included)

An improvement in the rating is not a credit to any one individual since it is an indication of the effectiveness of the shutdown in regard to over-all planning and execution. It is a credit to anyone making a contribution to the shutdown. Any improvement in planning, communications, cooperation, and effort will reflect an improvement in the "HODIG Rating".

TABLE 1—Work Load Calculation for a Typical Unit

UNIT: CRUDE NO. 3		DATE: JUNE, 1957			
Equipment	Job	No. of Jobs To Be Done	Work Values (Manhours Fig. 1)	Total Work Values (Manhours)	
Columns:	Clean	1	20	20	
	Clean and Inspect	3	40	120	
	Repair (Minor)	1	105	105	
Vessels:	Clean	4	20	80	
	Clean and Inspect	2	25	50	
	Repair (Major)	1	45	45	
Exchangers:	Clean (Mechanical)	13	25	325	
	Pull Bundle and Clean	22	30	660	
	Retube Bundle	1	75	75	
	Repair Heads	7	15	105	
Furnaces:	Clean and Inspect	2	120	240	
	Repair (Normal)	2	50	100	
Pumps and Turbines:	Clean and Inspect	10	2	20	
	Repair (Minor)	2	30	60	
	Repair (Major)	1	90	90	
Drives:	General	1	40	40	
	Repair (Minor)	1	30	30	
Pop Valves:		14	10	140	
Pipe Renewals:		6	25	150	2,455
General:	Piping	22 Percent			
	Instrumentation	7 Percent			
	Electrical	1 Percent			
	Preparatory and Clean Up	5 Percent			1,105
	Work Load Index				3,560

The rating has been validated only as a measure of over-all effectiveness. The standard values are not usable as a measure of effectiveness for work on the respective types of equipment. However, they are useful as an assist to the planning function. When the anticipated work is known, they can be used to give a quick estimate of manpower requirements. For detail planning, other job standards must be used.

There is another by-product of the HODIG which is useful. How valuable is planning? How much does a concentrated effort for better planning, better organization, and better control contribute, or rather, reduce the cost of the over-all job? HODIG has helped answer these questions. Figure 2 is an evaluation curve showing the effect of such concentrated effort. Three unit shutdowns are highlighted.

On one unit, the average shutdown labor cost has been $7 per workload index hour. Extra effort on preliminary planning and follow through reduced this cost to $5.60 per index hour on the succeeding shutdown. The savings per index hour was $1.40. For a shutdown requiring 4000 index hours, this was a savings of $5,600.

COIN. Since the HODIG rating measures only the over-all shutdown, something else was needed to measure the contribution of the respective crafts. For this purpose the Craft Operating Index Number was devised.

This index number measures the effectiveness of the craft for the entire work assignment over a period of time. It is not exclusively a measure of shutdown work. For a number of years data have been reported weekly on each craft giving the total hours spent, the hours spent on each type of work, and the number of jobs on which the work was done. This is the basis for the index.

Our accounting procedure accumulates charges and reports on three distinct types of jobs. One is our so-called Primary Accounts which are inclusive of all capital projects. Second are the blanket job orders which include miscellaneous and repetitive charges. Blanket orders are issued after study has determined that to issue individual job orders for each small job is more burdensome and costly than the job itself. Thus, a blanket order with a manhour budget is assigned to accumulate such a multitude of charges. All other work is charged to a regular job order and a job order must be issued before authority to do the job exists.

With this background of reporting it was not difficult to establish an aver-

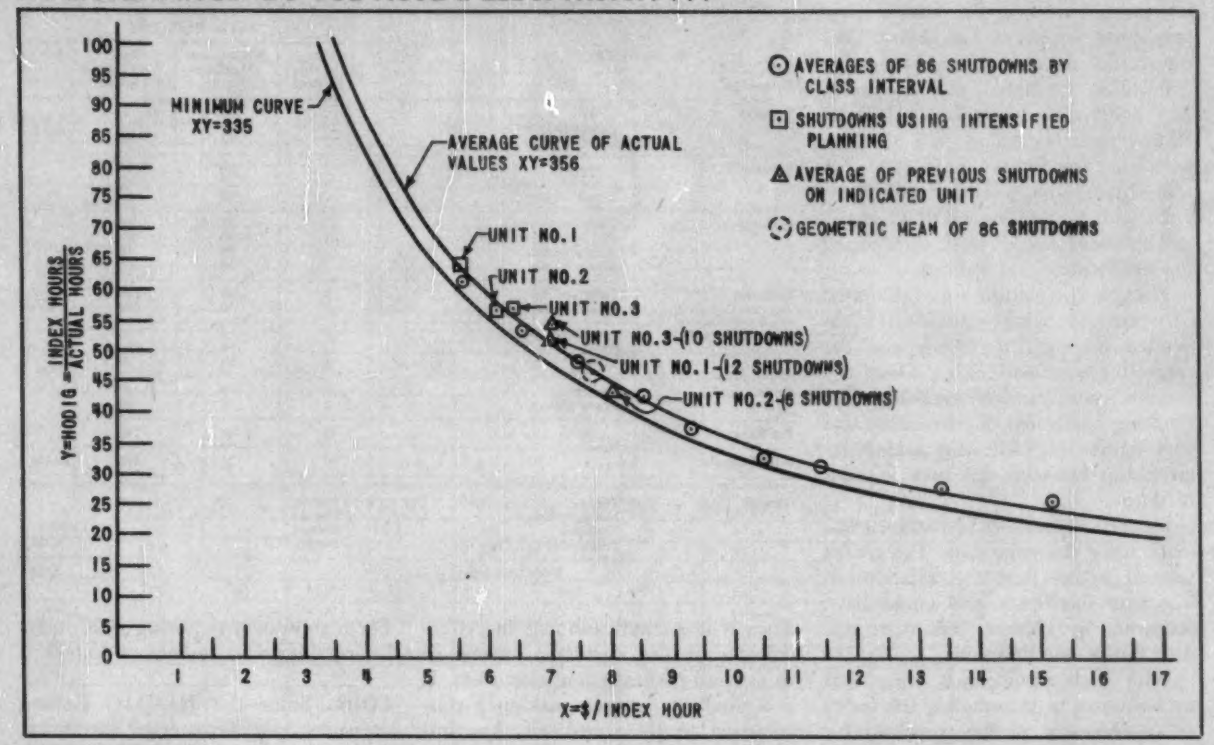

MINIMUM CURVE XY=335
AVERAGE CURVE OF ACTUAL VALUES XY=356
AVERAGES OF 86 SHUTDOWNS BY CLASS INTERVAL
SHUTDOWNS USING INTENSIFIED PLANNING
AVERAGE OF PREVIOUS SHUTDOWNS ON INDICATED UNIT
GEOMETRIC MEAN OF 86 SHUTDOWNS
UNIT NO.1
UNIT NO.2
UNIT NO.3
UNIT NO.3-(10 SHUTDOWNS)
UNIT NO.1-(12 SHUTDOWNS)
UNIT NO.2-(6 SHUTDOWNS)
Y=HODIG = INDEX HOURS / ACTUAL HOURS
X=$/INDEX HOUR

FIGURE 2—The extra costs of intensified planning were not included in the rating; however, they were small compared to the savings in actual man hours.

age job time for each craft. This job time was adjusted by data collected through job observations and work samplings. The result was a standard time per job for each type of work.

About the Author

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For a short time interval, this may not be valid, but over the long run, discrepancies will offset one another and the standard times are more valid. This is borne out also by the fact that as additional data are accumulated the standard time data vary very little.

From the weekly report, the data for hours worked and number of jobs on which the work was performed is accumulated for each craft. At the end of each quarter a tabulation can be made for each craft as illustrated in Table 2.

TABLE 2
COIN Report for One Craft

Craft-Insulators	Period Ending 3/31/57	
1. Total Output—Hours/Quarter	61,712	
2. Primary Accounts:		
a. Number Jobs Worked—170		
b. Standard Hours/Job—22.5		
c. Total Standard Hours	3,825.0	
d. Percent of Actual Hours		6.2
3. Blanket Orders:		
a. Number Jobs Worked—412		
b. Standard Hours/Job—40.7		
c. Total Standard Hours	16,768.4	
d. Percent of Actual Hours		27.2
4. Job Orders:		
a. Number Jobs Worked—1114		
b. Standard Hours/Job—13.3		
c. Total Standard Hours	14,816.2	
d Percent of Actual Hours		24.0
5. Index Numbers (Total Percent)		57.4
6. Last Previous Index		56.7
7. Average Index to Date		57.2

After the calculations have been made for each craft, a summary tabulation can be made for *all* crafts. The COIN Report is issued quarterly. This reports shows the COIN Rating for the current and previous periods. A third column shows the average rating to date. This column reflects the progress made and the rate of progress over a longer period of time. A fourth column shows the rank order among the various crafts.

Although the COIN Rating cannot be classified as exact a measure as the HODIG Rating, neither can it substitute for accurate individual job standards. However, on the theory that a reasonably sound and valid measure of labor effectiveness is better than nothing at all, both have been accepted quite favorably. In fact, it can be said that each report is anticipated with considerable interest by the supervisors. The enthusiasm expressed by the respective supervisors after reviewing the reports depends upon whether we have progressed or retrogressed from the previous rating. At least we are in a position to give an answer when we are asked "How did it go?" or "How are we doing?" # #

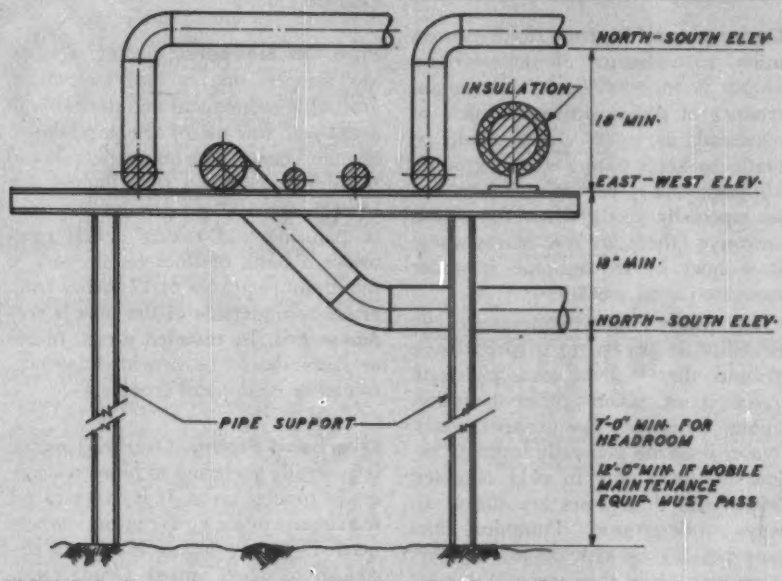


FIGURE 1—East and west lines are 18 to 30 inches above or below north and south lines.

Design Your Piping to Cut Maintenance Costs

A plant's piping system is designed only once. Maintenance goes on for years. More thought to maintenance during design results in fewer and shorter costly shutdowns.

W. A. Weiss
The Fluor Corporation, Ltd.
Los Angeles

IS PIPING design important to a maintenance program? If you have ever seen a crew of men digging a 100 foot long trench in order to jack a 6-inch underground line far enough away from a foundation to obtain the clearance needed to apply a pin hole repair clamp, you are aware of the importance of planning for maintenance in the design of piping.

Provisions for maintenance, to be successful, must be incorporated in the early stages of plant design.

Piping plays a major role in the design of the modern refinery, power plant, or chemical plant. Piping costs range from about 15 to as much as 30 percent of the total installed cost of a plant. Perhaps no other phase of design requires more careful study. The complete approach to this complex problem cannot be found in technical books. Years of practical experience go hand in hand with technical theory to produce a good sound design.

The designer is constantly faced with the problem of making a choice between minimum first installed cost, with a possible shorter life, or a higher initial cost with the probability of a longer economic life and lower maintenance requirements. The decision is not an easy one and the final choice is often a compromise. However, past experience indicates that certain practices can be incorporated into piping design without a noticeable increase in first cost, yet result in worthwhile savings from a maintenance viewpoint over the years.

This article highlights a few fundamentals of piping design that will reduce plant maintenance.

Selection Of Materials. Engineers responsible for selection of materials can improve maintenance design by standardizing the types or kinds of piping materials, for a particular plant. Selecting a type of valve with trim that is satisfactory for both process and utility service, instead of specifying identical patterns with one trim for process and another trim for utility is one example. Another is the selection of a style or pattern of valve that is acceptable for a large variety of services. When it is used in the less severe services, the result will be longer maintenance-free life. Higher first cost is often less expensive in the long run. The ever increasing popularity of the small cast or forged 600 lb. pattern valve replacing cheaper lower rated valves is a good example of this trend.

The careful selection of high quality valve packing at a slightly higher initial cost results in noticeable saving. It eliminates the need for stocking many kinds or styles and by reducing maintenance.

The decision to specify and stock only seamless steel pipe in one or at most two schedules for small sizes is usually economical. It also reduces the possibility of picking the wrong material from stock for replacements.

Standardization of fittings, especially in the small sizes, by specifying higher rated material which in turn can be used for a broader range of services is normally good practice. "Specials" should be considered only where they cannot be avoided.

Replacement and maintenance of piping because of corrosion has become a more serious problem with the higher pressures and temperatures of modern plants. In many cases it is better to specify thinner wall alloy rather than heavier wall carbon steel with a large corrosion factor.

The past decade has witnessed a tremendous expansion in the field of external coatings and internal linings or cladding of ordinary steels in an attempt to reach a compromise between the cost of solid corrosion re-

sistant metals with a longer life, and the lower cost of carbon steel with a much shorter life.

Since the earlier difficulties in welding aluminum have been overcome, it is rapidly becoming one of the more popular non-ferrous materials of construction. There are many services where aluminum can be specified for piping systems in which the somewhat higher initial cost is more than offset by its maintenance-free and longer life.

The field of non-metals or "plastics" has expanded tremendously since the war. When used intelligently with regards to limitations and advantageous properties, plastic materials can give excellent service with a minimum of replacement and maintenance.

Ductile cast iron is a comparative new comer to the field of metals for pressure piping. For many years the gap between ordinary cast iron and carbon steel has been too wide. Ductile cast iron should fill this gap. Indications are that it should be ideal for valves, flanges, and fittings for services which are just beyond the range of cast iron but yet do not require all of the strength factors of more expensive steel.

General Piping Layout. Orderly arrangement and correct spacing of plant piping contributes much toward reducing maintenance.

The routing and grouping of pipe lines must be carefully planned to shorten runs of large or expensive pipe, shorten lines with critical pressure drops and locate valves where they can be reached. Elevations of piping below and above ground are tentatively set to eliminate interference at crossings and directional changes. With complex piping it is not unusual to try several different layouts before deciding on a final one. A good piping layout will usually cause a rearrangement of much of the equipment on a preconceived plot plan.

Lines running in an east-west direction are assigned elevations 18 inches to 30 inches higher than those running in a north-south direction. The 18 inch differential is minimum and should be increased to 24 inches or 30 inches for plants with large piping (Figure 1).

Underground Piping. Inside process units, maintenance of underground piping is more difficult than maintenance of piping on low sleepers or overhead; so, every effort should be made to keep piping above ground. Underground pipe maintenance can be especially costly when the soil is corrosive (there are few places where it is not) or if the pipe is under concrete-paved areas.

In spite of the maintenance desirability of keeping pipe above ground, there will be some piping in every plant where other considerations outweigh maintenance costs. Water lines are generally installed below the frost line in cold climates. Sewer and drain lines are almost always underground. Pumpout lines may possibly be kept on low sleepers part way; but they generally cross traffic areas where burying is usually preferable to ramping over the pipe.

For lines buried in soil, consideration should always be given to (a) corrosion resistant wrapping for buried steel pipe, (b) use of cast iron rather than steel for low pressure service, (c) use of cast iron rather than vitrified clay or concrete for gravity sewer lines in areas subject to heavy traffic.

Buried lines should clear one another and foundations by at least the width of a shovel to facilitate repairs which inevitably will be required.

Deep valve boxes for buried lines should be designed with ample room inside the box for a maintenance man to bend over and use wrenches for tightening flanges or repacking valves.

Pipe In Trenches. Installing lines in concrete trenches, aside from being costly, is usually undesirable. Unless trenches are wide, shallow and properly vented, heavy gases may settle there to create a fire hazard the length of the trench.

For low suction lines crossing an important access way, short covered trenches may be the best design. If so, the trench should be made wide enough for maintenance access. Clearance from outside of pipe to trench wall should range from 6 inches for small shallow lines to 12 inches or more. If there are valves or flanges in the line they should clear the concrete by at least 3 inches; flange bolts and nuts should have wrench clearance from sides, bottom or end walls (Figure 2).

Pipe On Sleepers. Placing pipe on low sleepers one or two feet above ground is economical and desirable in areas with few pieces of equipment to be maintained. Pipe on sleepers should be high enough so that flanges are several inches above ground. For ease in painting and raking debris from under a bank of lines on sleepers, a minimum clearance of 12 inches from grade to underside of the pipe is recommended. In traveled areas, ramps or stiles should be provided for personnel or equipment crossings.

Overhead Piping. Overhead piping is generally preferred to pipe on sleepers in process areas. It is easier to get maintenance equipment where needed, yet the piping is more accessible than when buried. Grade clearance of overhead piping must be designed for the maintenance equipment needed. Twelve feet is usually sufficient height in a pump area for a maintenance truck. Pipe crossing main access roads into a refinery unit is frequently installed to allow passage of large truck cranes and may require 15 to 22 feet headroom. Inside the plant where there are no actual roadways, pasageways of sufficient width and height for maintenance equipment must be provided. This frequently determines the spacing of pipe supports and width of pipe lanes.

In spacing the pipe on overhead supports remember that: (a) insulators must have hand room outside the insulation in order to properly apply the covering, (b) the space between banked screwed lines must be sufficient for wrenches, (c) room for painting must be left between all lines, (d) hot lines must have room to accommodate expansion movements at elbows and tees and bowing of pipe near directional changes. A common layout practice is to arbitrarily assume that all lines are flanged and allow 1 inch clear spacing between the assumed flanges. With real flanges staggered, the resultant spacing between pipes is usually sufficient for installation and maintenance, although additional spacing may be required for very heavily insulated pipe or for insulating flanges (Figure 3). Pipe running parallel to vessels or buildings should be kept 12 inches to 18 inches

clear for insulation and paint maintenance.

Some compact plants are designed with overhead piping in two parallel banks. When this is necessary, sufficient space between the banks should be provided to allow working access to inner lines. A clearance of 18 inches is considered minimum.

Even in the best designed plants, new pipelines are frequently added after startup; main pipe-way supports should be designed with 10 to 25 percent excess width for future additions.

Hot Piping. Maintenance of machinery, especially rotating machines, is greatly affected by the design of connected piping. It is good design to make a separate study during layout of hot equipment and connecting piping. Moments and forces on rotating machinery caused by expanding and contracting piping should be kept within the limits set by the equipment manufacturer. Unfortunately some unenlightened pump vendors still say their equipment is unable to stand any forces from piping. Since it is impossible to meet such limitations, rules of thumb proven by experience must be applied. (See Wolosewick, "Equipment Stresses Imposed by Piping," PETROLEUM REFINER, Vol. 29, No. 8, pp. 89-91 (August, 1950).

An early study of the hot piping frequently shows the advisability of shifting or relocating equipment located on preliminary plot plans. Flexibility loops can often be eliminated, saving the cost of extra ells and sometimes pipe without increasing pipe forces on equipment (Figure 4).

Electronic computing machines are now solving most of the complicated pipe flexibility problems. Because of the tedious and voluminous calculations involved, complicated three-phase flexibility problems, when done without computers, are usually solved as three single-plane problems. Assumptions, all on the same side, are made and results often dictate flexibility loops which are necessary. Accurate calculations through use of computing machines often prove that fewer loops and elbows and less pipe is required for flexibility.

With the ease and speed of computing machines, less reliance need be placed on the experience and judgment of the piping layout designer. It is now feasible to calcluate forces on equipment caused by relatively small and "cold" connected piping. Maintenance is decreased when pumps and similar equipment are not overstressed.

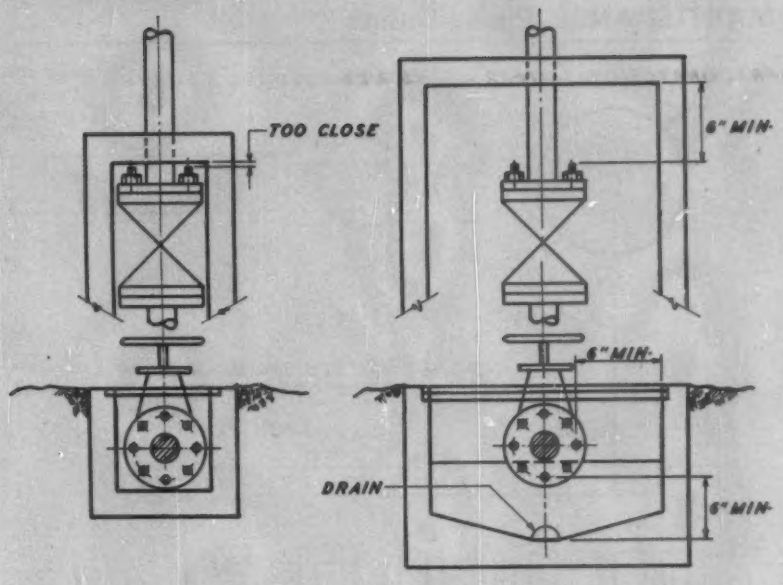


FIGURE 2—Valves in a trench should have six inches clear all around for easy maintenance.

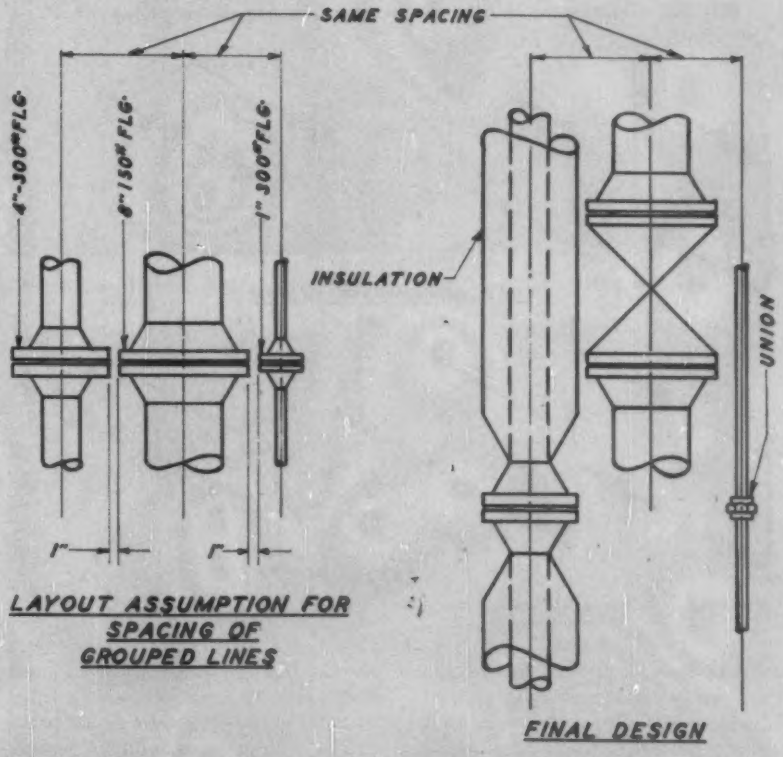


FIGURE 3—Line spacing—Assume all lines are flanged and allow one inch between the flanges.

Walkway Clearances. Walkway and workroom clearance around and between equipment must be considered by the piping designer. Much of the piping at pumps and exchang-

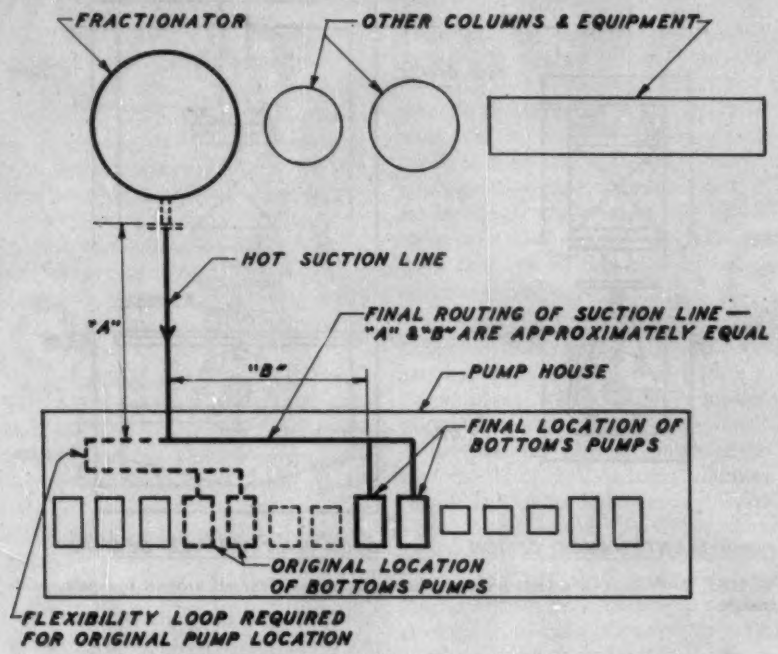


FIGURE 4—Loops can often be eliminated by studying the hot piping system.

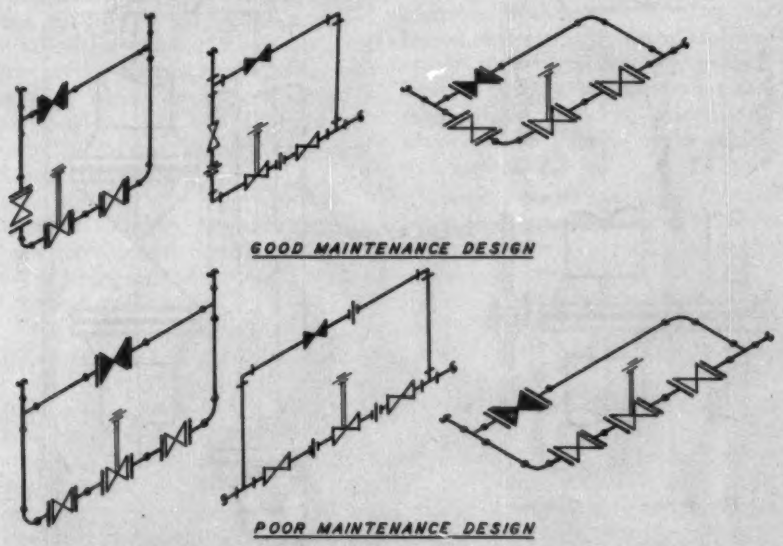


FIGURE 5—Poor maintenance design makes it difficult to remove control valves.

ers is outside of the foundation area. Two and one half feet is usually considered a minimum passageway width between pump or exchanger piping. Headroom should be seven feet or more. Large valves and especially their handwheels, must be carefully oriented to obtain proper work space around equipment.

Valve Access. A part of good piping design is the recognition of certain parts of the piping system which need more frequent repair or replacement. Sections of pipe subject to excessive erosion or corrosion, control valves, and relief valves are examples where ease of repair or replacement must be considered.

Common practice for control valve removal is to provide block valves and a hand controlled bypass. There are many arrangements for this piping that will operate perfectly well but are poorly designed from a maintenance standpoint (Figure 5). Good design will take into account that ring joint flanges must be separated to remove the gasket, that unions must be separated for removal, that flat asbestos gaskets are difficult to replace without some give in the piping, and that the bypass is usually being used during removal or replacement of control valves.

For servicing control valves in position, 12 inches minimum clearance should be allowed below the valve. This distance should be increased for welded-in control valves, to permit removal of the plug and stem. Control valves should be installed with stem vertical to minimize maintenance.

Large relief valves, which frequently must be placed on top of high columns or on an elevated vapor line, should be provided with davits for lowering to grade or truck. Other column internals such as caps and trays are also raised and lowered by means of the davit. It is good practice to route the piping to keep an open shaft from davit to grade and to clear all column exit openings (Figure 6). Large relief valves should always be installed in the vertical position and should be accessible for maintenance from a platform, grade or the floor.

Hand-operated switching valves require less maintenance than control or relief valve, but good practice is to locate them so they can be operated without the need of a chain and serviced without the need of a ladder. This frequently results in use of additional pipe to bring the valve near grade or a platform.

Block valves, used only during shutdowns or repairs, require the least maintenance, so general practice is to make them accessible from grade or a platform only when it can be done without additional piping expense.

Wherever a small or screwed line branches from a welder header, a block valve should be installed close to the header. Two-inch and smaller pipe can be damaged rather easily by maintenance equipment. The block valve permits repairs without shutting down a whole system.

Block valves in large lines for isolating units of a plant are desirable from a maintenance standpoint but expensive. Their use should be evaluated for each plant and each line. Many refinery engineers believe they

should be provided in all lines crossing the unit boundary.

Models. The use of scale models has proved invaluable in obtaining good piping layout, when valves, handwheels, flanges and insulation are added to the model.

With a model at the designer's elbow, it is next to impossible to overlook areas that are too congested. Scale maintenance equipment can actually be moved through the plant model in order to study removal or replacement problems. The piping layout work can be done directly on the model, or the model can be used to check paper layouts (Figure 7).

Replacing Pipe And Valves. Not long ago it was considered good piping design to provide breakout flanges about every 60 feet in line so that any section of pipe could be replaced without cutting or welding in place. Experience indicated, however, that the numerous flanged joints were themselves a source of maintenance and recent practice has shown a trend toward their elimination. In plants where the fire hazard is great and in-place welding requires elaborate preparations, it is still considered prudent to provide flanged equipment, vessels and valves, but intermediate breakout flanges are now confined to very special sections of piping where experience in similar plants shows frequent replacements will be necessary.

Maintenance engineers responsible for keeping a plant running between scheduled shutdowns have a difficult time deciding when a corroded or eroded section of pipe or a fitting needs replacement. During shutdown, holes can be drilled through the pipe or fitting wall and measurements made; but this does not assure that they have examined the weakest point.

To overcome this problem some engineers believe it is a wise investment to drill telltale holes part-way through the wall of the pipe and fittings at very frequent intervals. In straight runs of pipe, telltales are sometimes specified at 1 or 2-foot intervals spiraling around the pipe. Elbows, bend, tees, reducers and valves are given special consideration and as many as eight holes may be drilled at one ell. (Figure 8.)

Steam-Out Connections. Vessels or towers that require internal maintenance or inspection and have con-

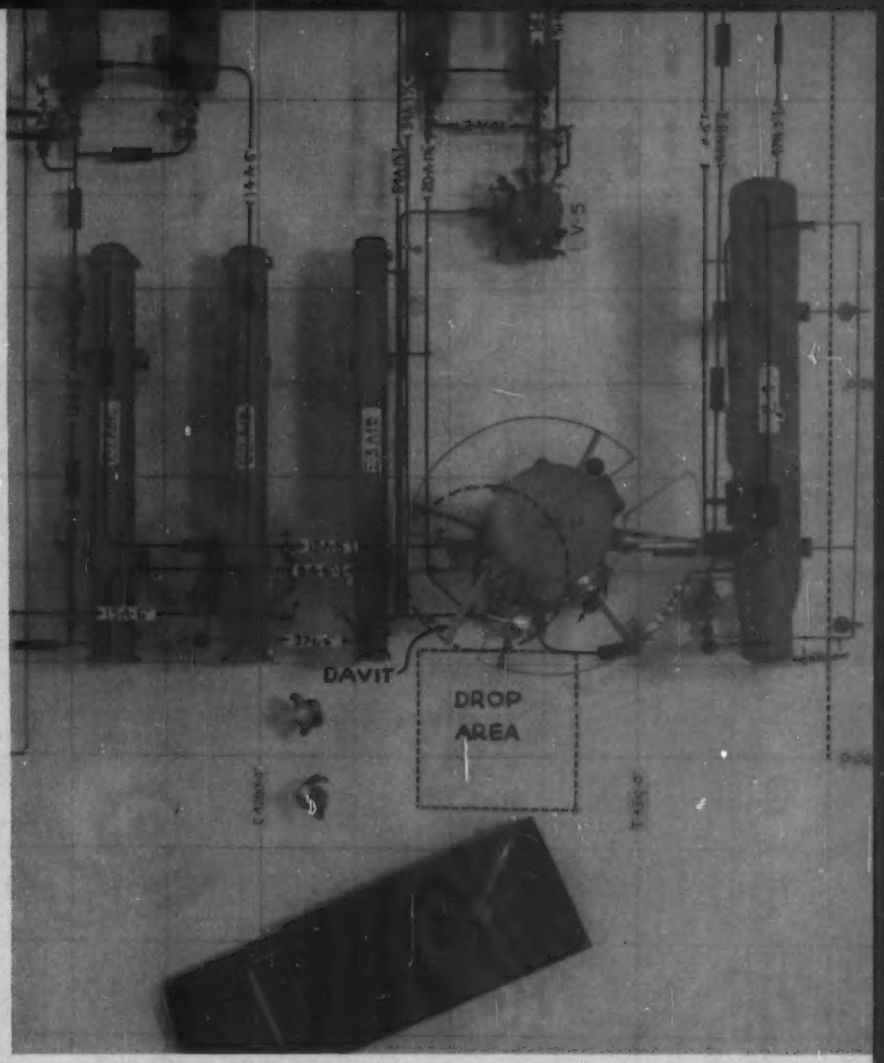


FIGURE 6—Provide clear areas so that davits can lower large relief valves to a truck.

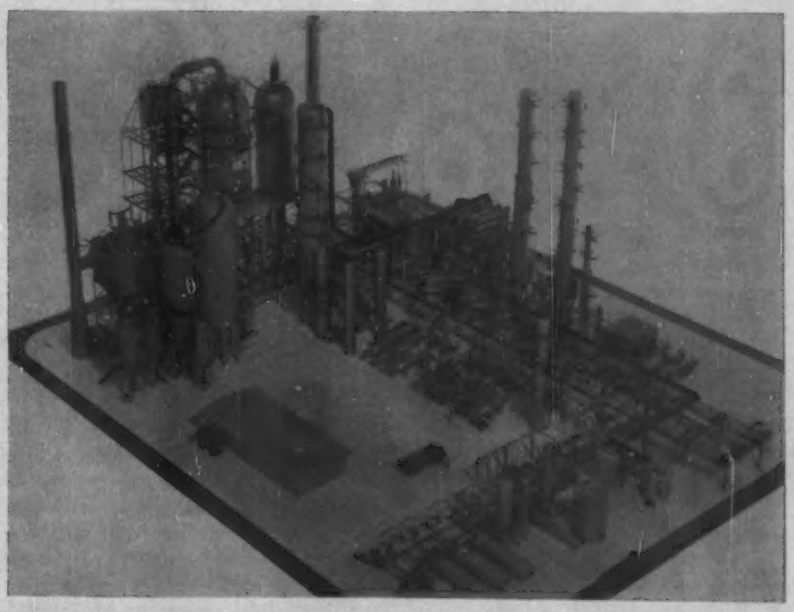
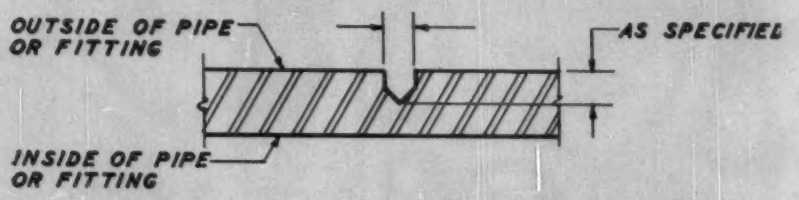
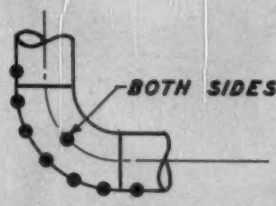


FIGURE 7—Scale models allow maintenance equipment to be moved through the unit for removal study.

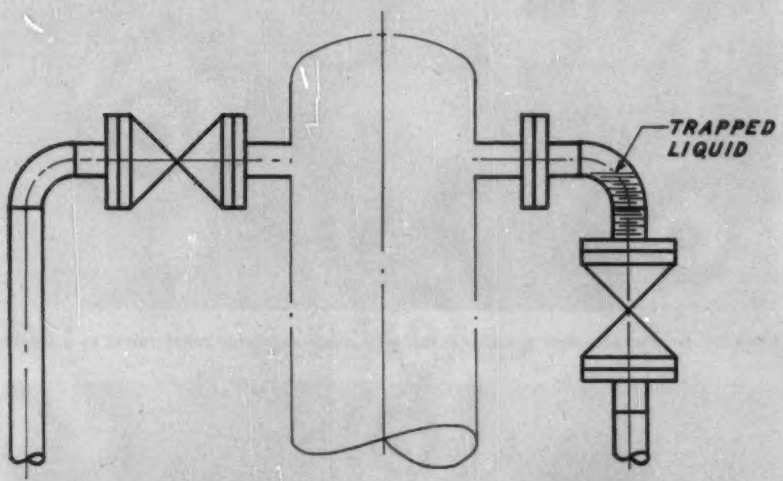


DETAIL OF TELL-TALE HOLE



TYP. LOCATION OF TELL-TALE HOLES FOR LARGE WELD ELL

FIGURE 8—Telltales reveal effects of corrosion on pipe and fittings.



GOOD MAINTENANCE DESIGN

POOR MAINTENANCE DESIGN

FIGURE 9—Horizontal, isolating valves insure drainage of vessels or towers prior to cleaning or inspection.

tents that are toxic should be provided with drains, pumpouts, vents and steam-out connections. Sometimes, it is also advisable to install isolating valves at nozzles. To facilitate complete riddance of the contents prior to steam-out, these isolating valves should be in the horizontal position (Figure 9).

Utility Hose Stations. For general yard and mechanical service, triple hose stations for steam, water and air should be provided at convenient points in the unit area. Stations should be located near enough to exchangers, furnaces, pumps, etc., so that all such equipment can be reached with a 50 foot hose. Stations should be at working levels for elevated equipment.

Vibration. Pipe vibration is the source of considerable maintenance in many plants. It can cause loosening of pipe anchor and guide bolts, damage concrete fireproof supports, loosen insulation, and in time, break weak spots in the piping system.

Vibration of piping may be caused by internal pressure pulsations or transmitted to the pipe by vibrating connected equipment. Internal gas pulsations can be effectively dampened by means of pulsation dampeners, and volume chambers partially filled with gas are sometimes used on liquid lines. With or without these minimizers of vibration, good piping design calls for a very careful study of lines where pressures are in excess of 1000 psi. Piping subject to vibration should be installed near grade as much as possible. Vibration is to some extent unpredictable, and it is extremely difficult to install additional adequate supports on overhead pipe.

Pipe Insulation. Insulation is another source of maintenance which can be minimized with proper design. To keep insulation from sliding and crushing itself on long vertical or sloping pipes (especially when there is vibration), support rings should be fastened to the pipe before installing insulation. Rings should be spaced about 12 feet apart.

When insulated pipe in sizes larger than 2 inches is supported on racks or sleepers, it should be elevated about 3 inches by means of a shoe. This eliminates the need of leaving gaps on the underside of the insulation at each support and is therefore easier to weatherproof.

Aluminum or galvanized steel insulation covering can be installed for little more than canvas or asbestos paper covers and should be specified for areas where insulation is subject to foot traffic or other abuse. ##

About the Author

William Weiss is chief of project design for The Fluor Corp., Ltd. In 1928 he joined Union Oil Co. of California, then in 1939 he went to work for Lloyd Corp., Ltd., where he became purchasing agent. He joined Fluor in 1942, and prior to assuming his present position, he was design coordinator and project engineer. Weiss' education in mechanical engineering was received at the University of Southern California.

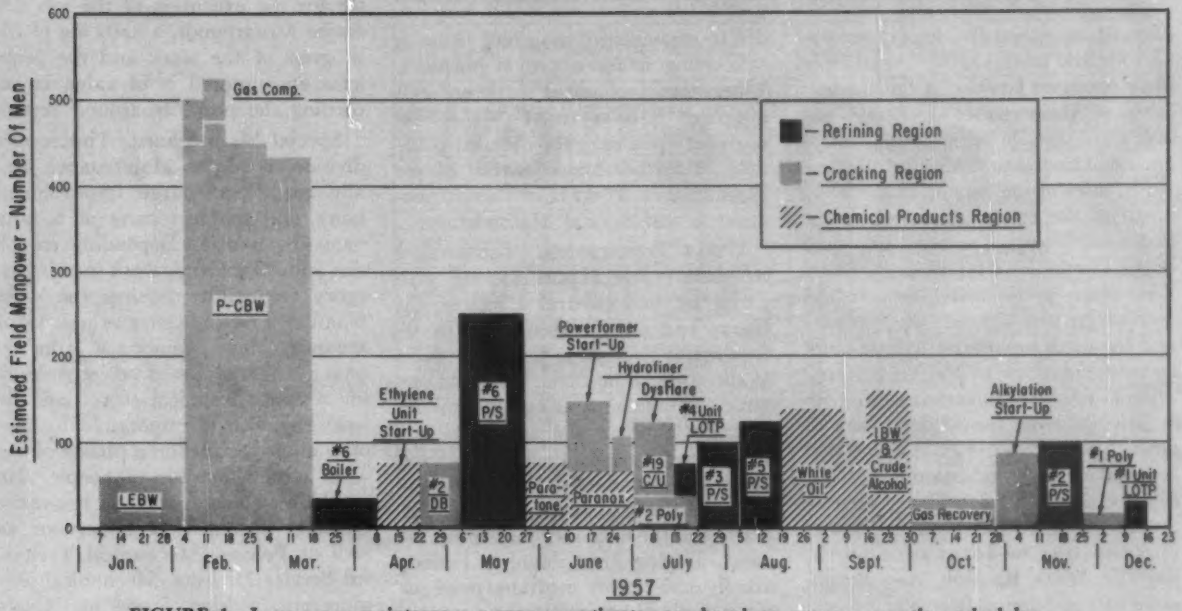


FIGURE 1—Long range maintenance manpower estimates are based on process operating schedules.

Modernize Your Maintenance Planning

To keep pace with today's changing procedures, a planning system of several years ago must be revised to minimize downtime.

Harry J. Knowlton
Esso Standard Oil Company, Linden, N. J.

MAINTENANCE PLANNING at Esso Standard Oil's Bayway refinery is a changing procedure. The planning system of several years ago would be entirely inadequate today at our modernized refinery with its new integrated production concept which makes the minimizing of equipment downtime a must.

A maintenance index measured as men per million dollars of investment or men per thousand barrels of throughput is the constant challenge. Such an index is revised periodically to reflect the improvement of methods and equipment which have been introduced into the refinery. The number of men represented in this index is divided into two categories, (A) Major Maintenance and (B) Regular Maintenance. We will describe the planning and utilization of these two blocks of Bayway's Mechanical Manpower.

A brief outline of Bayway's Process Mechanical organizational lines is given in order to understand the flow of communication required to plan for the maintenance of refinery equipment.

Bayway's Maintenance Division is divided into four operating regions which parallel the Process Division Organization. Region 1 — Atmospheric distillation operations, refining operations, steam, power, and other utilities. Region 2 — Thermal and Catalytic Cracking, Catalytic Conversion processes (fuel products) and High Pressure Light Ends Operations. Region 3 — Chemical Products Operations. Region 4 — Oil Movement and Storage Operations.

Each of these regions prepare long range Major Maintenance manpower estimates based on Process Operating Schedules. These estimates are combined into the Mechanical Departments Major Maintenance Schedule (See Figure 1). Manpower in excess of these requirements is available for distribution for Regular Maintenance among the various regions based on the complexity and severity of the region's process operation. Separate indices set up for each of the refinery's process units by a combined Process-Mechanical department agreement also guide the distribution of manpower available for Regular Maintenance. At weekly manpower meetings, scheduling engineers arrange for the necessary transfers of mechanics to adjust for sickness, vacations, training moves and peak Major Maintenance requirements. The end result of these statistical manipulations is the conforming to a predetermined budget of the mechanical manpower which can be economically

allowed to maintain the refinery at an efficient level.

Maintenance Level. "A Satisfactory Level of Maintenance" — here is our first challenge, it being so dependent on individual standards. An effective aid in minimizing repairs to the heart blood of the refinery, pumps, motors and compressors, has been the work of the Preventive Maintenance Team. This team periodically inspects this equipment throughout the refinery and forwards preventive maintenance recommendations to the region concerned. Each recommendation is vigorously followed up by this group to ascertain that appropriate action has been taken. Bayway's system of measuring maintenance level is by keeping a monthly score on the five key sections of our maintenance work, namely: Work Backlog, Key Equipment out of Service, Status of Inspection Items, Overtime and Plant Appearance. By establishing standards for each of these sections and applying percentage credits or debits for deviations, a trend of the maintenance level can be followed.

Bayway's field engineers are primarily responsible for the planning and scheduling of the refinery's work load. There is an average of three field engineers assigned to each of the four regions in the Maintenance Division. Although their functions are interchangeable, two of these engineers are planners, the other is a scheduler. Periodic betterment meetings are held by this group to discuss mutual problems and new methods.

Planning and Scheduling. The majority of requests for maintenance work usually originates in the Process Department. Here the work request is prepared on either of two forms; a Mechanical Order for Major Maintenance or a Minor Work Order for Minor Maintenance.

Major Maintenance. All maintenance jobs exceeding 10 man-days of work are classified as Major Maintenance. The original mechanical order initiating this work is given a preliminary cost estimate by the field engineer (planner) after discussion with the process initiator. It is then routed for approval through the various management levels, depending on the magnitude of the job. Although each mechanical order presents a rough estimate of manpower estimates and dollar expenditure, its chief value is bracketing it for approval purposes. When the mechanical work order is approved it is returned to the field engineer (planner) for detailed planning. A further breakdown of Major Maintenance Work is Unit Turnarounds and Special Maintenance.

Unit Turnarounds. Turnaround schedules (See Figure 1) are prepared by our Central Planning Group and revised periodically to reflect major changes in timing or scope of the work to be done. The field engineer (planner) assigned to the region containing the unit to be inspected works up a sequence plan for doing the job which includes an estimate of the manpower required by crafts and the necessary mobile equipment. During the planning period, usually about two months prior to the actual shutdown, he works from a recommended list of repairs compiled by the Process, Technical and Mechanical sections which are concerned with the unit. Each representative of the sections mentioned, is responsible for the final work list being free of jobs of questionable value. From this carefully screened work list, the total job is broken down in sequence steps and manpower estimates applied to each step. A percentage of every turnaround is blind planning. It is impossible to forecast accurately the internal conditions of the various towers and vessels on a unit until they are opened at the start of the shutdown. It has been Bayway's experience that departmental records of the units performance while on stream plus the post turnaround report from the previous inspection, can be evaluated to a point where the blind planning is minimized. While it is highly desirable that a packaged work list and plan be available several weeks prior to the turnaround, experience dictates otherwise. The changeable pattern of process operations, improvements which have been developed after the work list was prepared, unexpected deterioration of parts in the late stages of the unit's run are some of the variables that tend to shorten the life of a planning engineer. Shortly before the scheduled turnaround, orientation meetings are conducted by the field engineer to discuss the phases of the work with the zone and field supervisors who will be responsible for the execution of the job. On major turnarounds, a daily log of the progress of the work and the problems encountered is of value in recording the post turnaround report.

Special Maintenance. This second division of Major Maintenance usually consists of large improvement items and major repairs of a nonrecurring nature. Depending on job size and complexity, work in this category frequently requires the same planning treatment as unit turnarounds. Here again on a large repair job or a proposed project requiring a major technical correction, the field engineer is responsible for coordinating the planning phases of the work with a number of people. He would arrange for the necessary meetings with his Zone Supervisor, as well as Process, Mechanical Technical Service Division, Mechanical Engineering Division, Stores and Craft representatives.

Minor Maintenance. Jobs requiring less than 10 man-days work fall within this category and are executed on receipt of a minor work order which usually originates with the process foreman. Here in our opinion is the portion of our system of maintenance planning requiring the most study.

In planning down to the last available man we face the problem of constant disruptions occasioned by genuine emergency requirements. Conversely, it is economically unsound to have manpower standing by waiting for something to break. Our current practice is to segregate a section of the region's regular maintenance manpower allowance for minor maintenance. The actual assignment of this force is made on a tentative basis the day before the work is to be done. These men can be diverted by their field supervisor to work of an emergency nature on agreement with the Zone Supervisor and his process counterpart.

In each of the foregoing divisions of maintenance work, the procurement of non-stock material is the responsibility of the planning engineer. On occasions where a job requires the assistance of our technical division, a project engineer might order the nonstock material. Ordering of stock material is usually done by the field supervisor and in many instances by the mechanic on the job. # #

SERVICE SCHEDULE — MOTORS — SOLVENT TREATING PLANT

MOTOR No.	DRIVES P-PUMP C-COMP. F-FAN	SERV. FACTOR	LUBE G-GR O-OIL	HRS. WK. %	SERVICE	ELECT	MACH	RIG	SERVICE DATE	SERVICE DATE	SERVICE DATE	SERVICE DATE	SERVICE DATE
781	P 566	X	O	25	KERO TRANSFER	16	2	–		1-5-58			
825	P3339	X	O	80	COLD RAFF.	16	2	–	7-20-56			7-20-61	
829	P 684A	X	O	25	CAUSTIC CIRC.	8	2	–	4-4-57			4-4-62	
856	P3021	II	G	100	COOLING TOWER	16	4	–	12-27-56	12-27-57			
856	P3022	II	G	100	COOLING TOWER	16	2	–	4-18-56	6-2-58			
867	P3026	X	O	25	COLD RAFF.	16	4	–		4-14-58			
870	F6S	II	G	100	COOLING TOWER	8	2		10-25-56	8-9-57	8-9-58		
968	P3155	X	O	100	SO_2	16	2	–	2-16-56			2-16-61	
969	P3154	X	O	100	SO_2	16	2	–	6-25-56			6-25-61	
1019	P3201	III	G	80	CHARGE	8	2	–	8-19-55	8-29-57	8-29-59		
1021	P3203	X	O	100	HOT RAFF.	16	4	–	8-20-56			8-20-61	
1022	P3204	III	G	75	CAUSTIC CIRC.	16	2	–	1-25-56		1-25-58		
1023	P3205	III	G	50	CAUSTIC CIRC.	16	4	–	2-16-57		2-16-59		
1025	P3207	X	O	80	DIST. CHARGE	16	2	–	5-9-57			5-9-62	
1026	P125	III	G	75	CHARGE	8	2	–	12-19-55	12-19-57			
1148	F1N	II	G	100	COOLING TOWER	8	2	–	4-18-56	6-26-57	6-26-58		
1149	F3N	II	G	100	COOLING TOWER	8	2	–	9-14-56	7-19-57	7-19-58		
1363	F177	II	G	100	BLOWER EXHAUST	16	2	–	4-18-56	6-26-57	6-26-58		
1375	P3608	III	G	50	SEAL OIL	8	2	–	8-5-55	9-12-57	9-12-59		
1377	P215	III	G	25	SO_2 VAC. PUMP	16	2	–	9-4-56		9-4-59		

FIGURE 1—The "tickler" file consists of sheets like this that make planning easy.

Planning Electrical Maintenance?

Realistic dollar figures can be placed on preventive maintenance by using this system. The result is reduced costs.

Anthony J. Sullivan
Tidewater Oil Company
Avon Refinery, Associated, Calif.

YOU MAY be missing a good bet if you have overlooked the advantages of "planned" electrical maintenance. The problem of electrical equipment scattered over many acres with typical refinery shutdown problems has plagued many a good maintenance supervisor.

The solution found at Tidewater Oil Company's 115,000 barrels per day Avon refinery, near Martinez, Calif., is the one of an electrical manpower planning and scheduling concept. Such a system has been in effect since 1953 during a load growth from 18,000 KVA to 33,000 KVA. The basic system has shown its versatility by requiring no basic changes. Of course, any system must be flexible enough so that modifications may be made to meet changing conditions while retaining its full usefulness. Maximum continuity of service consistent with a realistic operating budget is of prime interest to anyone responsible for maintenance.

The concept of complete equipment overhaul and servicing at each unit shutdown will produce results. But can the expense be justified? At the other extreme, servicing on a hit and miss schedule and "be sure to get them when they fail" will show up as a penny wise and pound foolish procedure. The experience of Tidewater's maintenance forces strongly suggests a negative answer to both premises. Instead each unit of electrical equipment is serviced at predetermined intervals by a predetermined amount of manpower.

This may sound complicated and to a certain extent it is. However, once equipment manhours are determined for proper maintenance and the schedule set up, the desired results can be obtained.

Maintenance Interval. The first phase of this planning concept is the determination of the timing or proper maintenance intervals. Several methods are available of which the best is undoubtedly past hard experience. This may have to be modified with manufacturer's recommendations on new types of equipment. In some cases, the manufacturer's recommendations may be the basis for the initial program and then modified as experience is gained.

Scheduling and execution at the Avon refinery are obtained through a formal over-all plant program. Eighty to eighty-five percent of all maintenance manhours are planned and scheduled for each specific job. Maintenance has its place along with unit shutdowns, repair, modification and authorized new construction work. A complete description[1] of this system is beyond the scope of this article. However, maintenance, particularly electrical maintenance, re-

ceives its proper emphasis and will be described in some detail.

The refinery is divided into three areas each of which has a staff responsible for all work done within its area. Mechanical job orders are the medium through which maintenance and all other work is accomplished. They must be authorized by the operating supervisor having direct responsibility for the specific equipment.

The operating supervisor, though, does not carry the responsibility of keeping electrical equipment records and determining the maintenance sequence. This function is left to the maintenance department. The electric shop, however, has only the responsibility for equipment history after maintenance work is done. From the operating supervisor's viewpoint all he sees are job orders prepared for his signature which, during the year will complete all necessary work. This, in turn, has been predetermined to provide optimum equipment performance at minimum cost.

The central maintenance staff has the responsibility for both long range and daily planning and the determination of manpower availability. A yearly schedule is issued through which the individual areas know when to expect the necessary manpower. The basis for this schedule is the total number of maintenance manhours required for the year. This is proportioned according to area needs. This, of course, involves other crafts besides electricians, such as machinists and riggers. This system must be flexible to adapt to various circumstances and the schedule is reviewed quarterly to bring into balance any discrepancies. Then the area staff, with the aid of a "tickler" file, arranges downtimes for the equipment scheduled during that period. Full advantage is taken of unit shutdowns, if there is a reasonable coincidence of schedules.

Tickler File. The "tickler" file (see Figure 1) is the heart of the maintenance system. It must be prepared with care and its importance must be well understood by the person with direct responsibility over it. The file is made up in loose-leaf form, by units, with provisions for showing the equipment, service factor, date of last servicing and due date of the next servicing. Each area reviews this file monthly and makes a brief report of the current standing.

The actual daily planning can then be accomplished, the maintenance work performed and notations made on individual equipment record cards. The electrician doing the work is given a card (see Figure 2) by the electric shop foreman on which is recorded pertinent maintenance data. This information is later transferred to permanent record cards.

FORM 5300 2M 9-56

MOTOR SERVICE CARD

CREW: Scott 1/C
Huddleston 1/C

MOTOR No. 1012 HP 15
GREASE ✓ OIL
LOCATION No.2 Stabilizer
NEED RIGGERS? NO
BEARING OPE FAF 312 K old
ND 312 new
BEARING PE SAME old
new

MEGGER READINGS:
Motor Windings ✓
Motor Circuit ✓
Control Circuit ✓

WIRE SIZE:
Motor Circuit No. 10

CONDITION OF CONTACTS:
Good
Fair ✓
Replaced
DATE COMPLETED 6-7-57

FIGURE 2—The electrician, after working on a motor, notes its condition on this card.

The following procedures are applied to specific equipment:

Motors. All motors were given an "operating factor" when the system was first set-up. This was determined by the service conditions of each particular motor. In addition, the operating department was asked to give the number of running hours per month during normal operation. With this information available, the frequency of servicing was determined. Since the great majority of the 2500 motors are TEFC, external visual inspection performs no useful function. The following procedure was used: electricians disconnect the leads, break the couplings and perform the actual servicing. Machinists realign the motor with the driven equipment and riggers assist as necessary.

Servicing may be defined as: (1) tearing the motor down, (2) inspection, (3) cleaning and relubrication or renewal of bearings, (4) cleaning of stator and rotor and (5) reassembly. Whether this is done in the shop, the preferred method, or in the field, depends on accessibility, indoor or outdoor location and weather conditions.

SERVICING SCHEDULE

Six-Month Service. Grease lubricated, continuous service, 100 percent operating factor, troublesome history or unusually bad operating conditions.

One-Year Service. Grease lubricated, continuous service, 100 percent operating factor.

Two-Year Service. Grease lubricated, 50 percent to 99 percent operating factor.

Three-Year Service. Grease lubricated, 1 percent to 49 percent operating factor.

Five-Year Service. All oil lubricated, sleeve bearing motors.

The use of oil lubricated, ball bearing motors has not been found advisable. New motors are grease lubricated, ball bearing for 50 horsepower and under, and oil lubricated, sleeve bearing for 60 hp and over.

Oil-lubricated sleeve-bearing motors are checked at least once a week; some twice a week. One man spends full time inspecting oil levels, adding oil as necessary and changing dirty oil. Oil is changed when motors are running if this is necessary because of operating conditions, with the exception of critical motors. During unit shutdowns, the oil is inspected on all motors. The motor oiler also acts as a roving electrical system checker, reporting any potential trouble. Conditions of motors, starters, circuits and other electrical equipment in need of attention are recorded and planned repairs are made.

Synchronous motors are inspected daily by the afternoon-shift electri-

cian. Minor repairs are made as necessary. In addition, eight hours per week are allotted to routine maintenance such as replacing brushes, polishing slip rings and commutators and changing starter contacts. Any major repairs, such as turning commutators and slip rings, and bearing repairs or overhauling the motors, are reported by the men performing the daily and weekly checkups.

Motor Starters. When each motor is serviced, its respective starter is also serviced. Additional planning is necessary when motors are not serviced every year. This has been determined as the optimum service sequence for starters. Advantage is taken of unit shutdowns so that the one-year servicing may be accomplished. Servicing involves checking the condition of (1) the oil, (2) contacts, (3) overload, and (4) carbonization deposits, with replacement and repair as necessary. Overloads are calibrated when required with special equipment assembled for this purpose (see Figure 3). Special attention is paid to motor starters, on applications involving high viscosity products.

Circuit Breakers. When this system was first established, only three substations were involved. Two of these had no facilities for shutting a breaker down without disrupting that particular service. Since power is still required for welding, lighting and other miscellaneous services during unit shutdowns, these breakers were serviced at odd intervals. Four new substations have since been placed in service and two of the original are in the process of being replaced. All of the new facilities include a transfer bus scheme and the breakers may be taken out of service at anytime. A procedure of yearly servicing has been worked out and is being initiated. A card file is set up to include each individual breaker. Service history, plus date of last servicing and the date of the next servicing, is recorded. The responsibility for this procedure is placed in the utilities division of the operating department, because of the limited number of breakers and the specialized nature of the servicing. Breaker servicing, spread out over a 12-month period, will include checks of oil purity, contact conditions and calibration of overcurrent relays.

FIGURE 3—Special equipment is used to calibrate overloads.

Lighting Equipment. One man has a full-time job of replacing lamps. This method has been found advantageous, because of the wide dispersion of lighting facilities. However, in the engineering department, lamps have been replaced on a yearly group replacement basis for the past two years. Fixtures are washed at the same time. This has resulted in appreciably higher maintained lighting levels.

Ground Detection. The afternoon and graveyard electrician each have one part of the refinery to check for grounded circuits. The ground detectors are checked everyday with observations reported in the electric shop log. Grounds are immediately traced-out and corrected. This emphasis is necessary with the ungrounded distribution system at Avon.

Summary. The Tidewater system allows a realistic dollar figure to be placed on preventive maintenance which in turn may vary from the bare minimum to the most comprehensive program. Another advantage of this system is the ease of application to large or small electrical systems in plants which have a well organized maintenance organization. The positive emphasis placed on the planning and scheduling concept has definitely resulted in improved electrical maintenance at Tidewater's Avon Refinery.

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About the Author

Anthony J. Sullivan is an electrical engineer for Tidewater Oil Company, Associated, Calif. He received his B.S. degree in electrical engineering from the University of Louisville in 1946, and his M.S. degree also in electrical engineering from Case Institute of Technology, Cleveland, in 1950. Prior to joining Tidewater in 1954, Sullivan was a Lieutenant in the Navy; and a design engineer for Columbia-Geneva Steel Co., Pittsburg, Calif.

SPECIAL MAINTENANCE REPORT

How Epoxies Can Simplify Maintenance

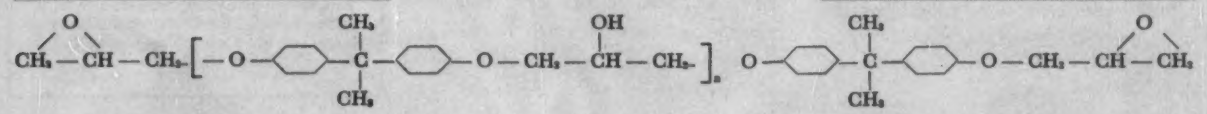
Epoxy coatings are tough, chemical resistant and prevent undercutting by rust. This versatile material can also be used to patch holes in tanks or pipe where flammable vapors are present.

FIGURE 1—(Before) Removal of the coating revealed this hole in a crude storage tank.

E. R. Scogin and H. W. Howard
Shell Chemical Corporation
Houston

EPOXY RESINS, properly formulated into coatings and applied, are simplifying corrosion maintenance problems and cutting the annual dollar loss due to atmospheric and chemical corrosion in oil refineries and petrochemical plants. The surface coatings based on these resins are suited for this job because of their versatility and the combination of properties they exhibit; excellent adhesion, flexibility, toughness and, most important, chemical resistance, thus combining in one resin the outstanding characteristics of many other types of resins.

The basic raw materials for epoxy resins are derived from petroleum. These resins are the condensation product of bisphenol-A and epichlorohydrin. Epichlorohydrin is made from propylene via allyl chloride. Bisphenol-A is prepared from acetone and phenol, these being derived from propylene and benzene respectively. The molecular structure of epoxy resins may be given as follows:



The aforementioned properties of epoxy resins are best explained by the examination of the above structural formula. It will be noted that the structure is based on carbon-to-carbon bonds and ether linkages. Since the ether linkage is among the most stable known to organic chemists, it is not surprising to find these resins highly resistant to attack by all types of chemicals. The reactive hydroxyl and epoxide groups are widely spaced along the chain and thus are far enough apart to give rise to the unusual flexibility exhibited by the cured resin. The outstanding adhesion of

cured epoxy resins is attributed to the polar nature of the molecule.

Epoxy resins vary in molecular weight and reactivity and range from viscous liquids to hard, tough solids. The vast majority of epoxy resin based paints are manufactured from but not limited to the solid grades.

Types of Epoxies. Because of the chemical nature of the epoxy resin molecule, they will not produce a suitable protective surface film in themselves. However, combined with the proper catalyst, curing agent or other resins, they produce surface coatings having a combination of properties unmatched by other commercially available coatings. The epoxy surface coatings of commercial significance can be categorized into four major classes of modification:

- Epoxy-amine
- Epoxy-esters
- Epoxy-phenolics
- Epoxy-ureas

Of these, epoxy-amine and epoxy-ester systems are used for structural maintenance coatings in and around oil refineries and petrochemical plants, while epoxy phenolics and epoxy ureas are used for protecting equipment and in vessel, tank car and drum linings.

The first system, epoxy-amine or cold-cured (ambient temperature) is unique in that it offers a degree of chemical and solvent resistance normally associated with conventional baked coating systems. The curing mechanism of the amine cured expoxy resin formulation is such that air need not be present to effect full cure, since polymerization is due to the reaction of polyfunctional amines with epoxide groups of the resin.

Resistance to undercutting of epoxy films by rust at points of mechanical damage to the coating adapt epoxies quite well to maintenance finishes. This property is present in all epoxy systems, but particularly outstanding in epoxy-amine cured coatings.

Amine cured systems are best utilized in areas of heavy corrosion caused by continuous contact with crude oil and chemicals in the form of spills, leaks and atmospheric effluents. This system has been evaluated by several oil companies for resistance to sour crude oil in salt water disposal wells and was found to be superior to all other room temperature cured coatings tested for this service.

In areas where extremely heavy films are required, amine cured epoxy mastics are being used increasingly. An example of such an area of use is the off-shore drilling rig. The success of these coatings in combating corrosion caused by salt water has been outstanding. Recently an examination of Shell Oil Company rigs above and below the water line showed the general condition of the paint to be excellent. No blistering, checking, cracking or other paint breakdown was observed on rigs coated three years ago.

The amine cured type of epoxy resin maintenance paint is necessarily a two-package system, the resin solution in one and the amine curing agent in the other. After the addition of the curing agent, the pot life or stability of the resulting system varies (8-24 hours) according to the ambient temperature of application and the specific formulation involved. Prior to the addition of the curing agent, this coating system has an infinite storage life.

In areas of low or medium corrosion in industrial plants the epoxy esters are widely used. Esterification of epoxy resins with drying oil fatty acids result in resins that dry by oxidation. Such coatings do not have as good chemical resistance as the straight epoxy-amine system but they are superior in chemical and solvent resistance to alkyd paint systems. Long oil esters based on linseed oil are preferred in prime coatings, while long oil esters based on soy oil are preferred in top coats. These are the most widely used epoxy esters.

White epoxy-ester tank coatings are receiving increasing attention in refinery and petrochemical storage areas. Here a combination of good metal protection, effective heat reflection and good appearance make these coatings very desirable in this application. Epoxy-ester coatings can be easily formulated with closely controlled chalking rate that will keep tanks clean and white, maintaining maximum heat reflection and good appearance with an extremely slow rate of loss in film thickness. Film thickness loss due to chalking of epoxy-ester coatings over a five-year period have been so small that it is difficult to measure.

Where baked systems are feasible, epoxy-phenolic and epoxy-urea systems offer optimum chemical and solvent resistance combined with flexibility, hardness, and toughness. Epoxy-phenolic systems find use in oil refinery and chemical plants for coatings on laboratory equipment, for chemical processing equipment and piping, linings for storage tanks and equipment, tank car and drum linings.

The epoxy-urea system has slightly less chemical resistance than epoxy-

FIGURE 2—(After) Using an epoxy resin patch kit, the tank is ready for service.

phenolics but have better color retention. They are used for coating laboratory furniture, can and drum coatings, baking primers and chemically resistant baking enamels.

Application. It must be remembered that the success of any coating is dependent upon proper surface preparation and application. The best surface preparation is obtained by sand blasting and this preparation should be adhered to when applying epoxy-amine, epoxy-phenolic and epoxy-urea coating systems. Epoxy esters may be applied over surfaces that have been wire brushed and they may also be applied over old finishes which have been properly cleaned, but it should be remembered that adhesion of the entire system is dependent upon the adhesion of the old finish.

Other Coatings. Other coatings which find wide use as maintenance coatings are vinyls, chlorinated rubber and alkyds. Vinyl coatings are similar to the epoxy resin systems as to chemical resistance, but differ in that they exhibit less adhesion and solvent resistance. This poor solvent resistance can be attributed to the fact that they dry by solvent evaporation and, therefore, are subject to resolution on contact with solvents. The epoxy resin systems also differ from vinyls in application. Because of the greater solubility of epoxy resins, higher solids vehicles may be sprayed and hence greater film thickness may be obtained with the epoxy resin system than with vinyl systems.

The outstanding advantage of chlorinated rubber systems is their resistance to alkalies and to some extent weak mineral acids. Because of their alkali resistance, these coatings are widely used for concrete where they can resist the alkaline nature of concrete. They, like vinyls, differ from epoxy resin systems in application, adhesion and solvent resistance.

Both systems—vinyls and chlorinated rubber—are sensitive to the condition of the substrate to which they are to be applied. To improve their adhesion sand blasting is a necessity.

Alkyd systems are similar to epoxy esters in that they dry by oxidation; however, the epoxy esters exhibit much better chemical resistance. (Table 1 gives comparative properties of the various maintenance coatings.)

Patch Kits. Patch kits based on epoxy resins, aliphatic amine curing agents (ambient temperature cure) and glass cloth have proved to be a useful addition to the family of maintenance materials. In the past where the repair involved welding, the equipment and the entire work area must be made free of flammable gases. When a column, vessel, or tank must be entered by the workmen for internal repair, the cleaning and decontamination procedures were even more complicated. Both types of repair result in additional costs due to loss of production and added man hours. Effective use of epoxy patch kits is cutting these costs considerably.

The chemical and physical properties of the epoxy resins make them useful as patching materials. Since no flame or high temperature is required for the application and curing of the resin, the material may be used in areas where flammable vapors are present.

Patches should be limited to equipment where the operating temperature will not exceed 250 F. The surface of the metal must be well cleaned before application, and at least six hours must be allowed for the resin to cure at room temperature. By use of heat lamps or aluminum foil jackets and steam, patches can be cured and equipment put back in operation often within one hour or less.

Shell Oil Company and Shell Chemical Corporation have found use for patch kits in repairing crude product storage tanks, (see Figures 1 and 2) column feed nozzles, pressure vessel walls, heat exchange nozzles, finished product storage tanks, fume ducts and product transformer lines.

Epoxy adhesives are also being used as maintenance materials without the glass cloth in repairing cracks in various pieces of equipment and as pipe dope instead of seal welding in hazardous areas.

Continued research is leading to new application discoveries to aid maintenance engineers in the many problems they encounter in oil refineries and petrochemical plants.

##

TABLE 1

Comparative Chemical, Physical and Application Properties of Epoxy Resins and Other Maintenance Coatings

PROPERTIES	Epoxy Amine	Epoxy Ester	Vinyl	Chlorinated Rubber	Alkyds
Chemical Resistance					
Acids	Excellent	Good	Excellent	Fair	Poor
Alkali	Excellent	Good	Excellent	Excellent	Poor
Solvents	Excellent	Good	Poor	Poor	Poor
Physical Properties					
Flexibility	Good	Excellent	Excellent	Good	Good
Adhesion	Excellent	Excellent	Poor	Poor	Good
Hardness	Excellent	Excellent	Good	Good	Good
Abrasion Resistance	Excellent	Excellent	Good	Good	Fair
Application Properties					
Method	Spray, Brush, Roller	Spray, Roller, Flow, Brush, Dip	Spray, Roller, Brush, Dip	Spray, Roller, Brush, Dip	Spray, Roller, Flow, Brush, Dip
Solids @ Spray Viscosity					
Clear	40	35	20	25	40
Pigmented	55	50	25	30	50
Film Thickness per Coat mil	1.0–2.0	1.0	0.4	0.5–0.6	.75–1
Dry and/or Cure	Chemical Curing	Oxidation	Solvent Evaporation	Solvent Evaporation	Oxidation
Gloss Retention	Poor	Fair	Excellent	Fair	Excellent
Color Retention	Fair	Good	Excellent	Poor	Excellent

About the Author

E. R. Scogin is district manager of Shell Chemical Corp., Houston, where he does marketing, management, and market and product development work. Scogin received his B.S. degree in 1940 and his M.S. degree in 1941, both in chemistry from North Texas State College, Denton. Following graduation, Scogin remained at North Texas State for a year as a chemistry teacher, then in 1942 he joined Shell as a chemist where he remained until 1944 when he was made a salesman. In 1946 he was promoted to his present position as manager of the Houston district which includes Texas, Louisiana, and Mississippi.

How to Prepare for Chemical Cleaning

The right preparation can insure a better, safer cleaning job, with less downtime for your unit.

Ivan Bielek
Dowell Incorporated
Cleveland, Ohio

MANY REFINERS have found that it is more profitable to utilize the experience and specialized equipment of chemical cleaning contractors than to clean operating equipment themselves. Such service companies use chemical solvents to remove troublesome deposits, thus increasing the operating efficiency of the equipment cleaned. Such benefits can be increased by careful preparation before the contractor arrives. The right preliminary procedures can insure a better, safer

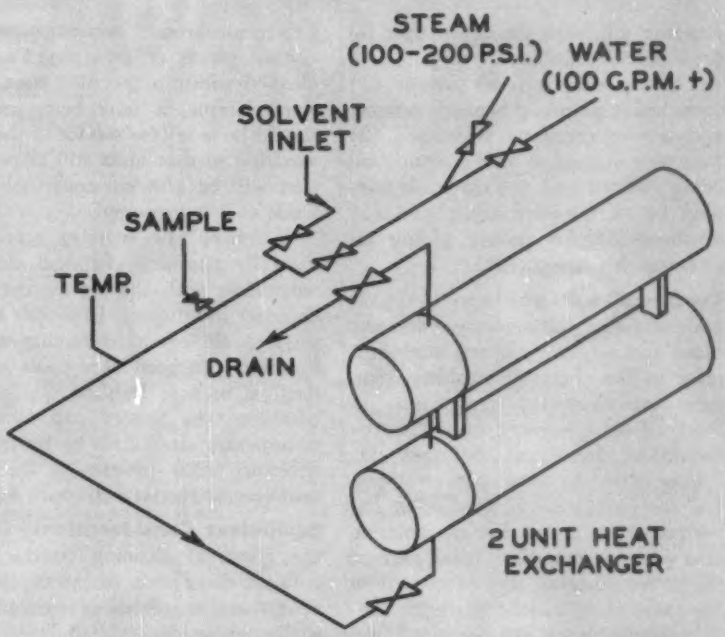


FIGURE 1—Use at least 1½-inch pipe on heat exchanger piping.

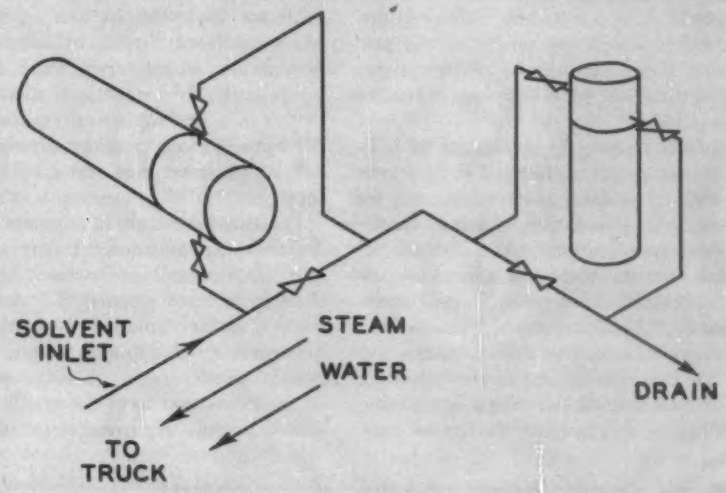


FIGURE 2—For non-stacked exchangers, a bypass is used.

TABLE 1—Refinery Equipment Usually Cleaned Chemically

HEAVY OILS	
Process or Product	**Equipment Cleaned**
Power Plants	Boilers, Condensers, Feed Water Systems, Filters, Deaerators, Steam Lines, Air Pre-heaters, and Water Wells.
Crude Distillation	Gasoline Stills, Gasoline Condensers, Naphtha Coolers, Kerosene Coolers, Crude Preheaters, and Towers.
Pipe Stills	Sour Crude Lines, Overhead Vapor Condensers, Prefractionating Condensers, After Coolers.
Lube Oils	Ammonia Condensers, Propane Dewaxing Condensers, and Chlorex Plants.
Thermal Cracking	Gasoline Condensers and other Light End Condensers.
Miscellaneous	Gas Burning and Flare Lines, Waste Lines, Tanks.

LIGHT OILS	
Process or Product	**Equipment Cleaned**
Catalytic Cracking	Flue Gas and Slurry Boilers, Catalyst Blower Turbine surface Condensers, Slurry Exchangers, Gasoline Condensers, Hot Oil Pump Gland Water Systems, Hydraulic Oil Control Piping, Start-Up Gas Lines, and Engine and Compressor Cooling Jackets.
Vapor Recovery Plant	Debutanizers, Depropanizers, Deethanizers, Tubing Shell Vessels, High and Low Gasoline Stills, Propane Rectifiers, Absorber Columns, Reflux Vapor and Water Lines, and Reflux Drums.
Alkylation	Ammonia Condensers, Stratco Contactors, Deisobutanisers, H, F Stripper and Regenerators and Product and Coolant sides of Condensers.
Isomerization	Toxic Aluminum Chloride and Antimony Trichloride Residues from: Deisobutanisers, HCl Strippers and Catalyst Removal Columns.
Catalystic Reforming	Heaters, Feed Lines and Other Miscellaneous Equipment where noble Metal Catalyst Contamination presents a Problem.

cleaning job, with less down time for the refinery units involved.

These preliminaries include (1) cooperative planning between refinery and service company personnel, (2) thorough discussion of the equipment being cleaned and the materials handled by this equipment, and (3) arrangements for proper piping for cleaning this equipment.

Cooperative Planning. Complete understanding and agreement between plant and service company engineers, prior to the chemical cleaning treatment, are extremely important. In most cases, a refinery coordinator should be present at the work site. Proper liaison between units on stream and the unit being cleaned is an important safety factor. For example, an acid solvent from a unit being cleaned might be dumped into a sewer. At the same time, caustic material containing sulfides might be dumped into the same sewer from another unit, such as a mercaptan scrubber. These two would mix, generating poisonous hydrogen sulfide gas which would present a serious hazard. With proper coordination, such happenings can be avoided.

It is frequently important to have present a man authorized to direct the work of various union crafts. If, for example, a leak should occur, service company personnel have no jurisdiction over the craft which should repair the leak. On occasion, several hours have elapsed before a person with proper authority could be found.

A particularly important aspect of the question of coordinating cleaning efforts is the possible savings of time. Often turnaround schedules call for certain pieces of equipment to be cleaned within a specified time limit. For example, a tank being cleaned should be ready for service at the time specified so that units still in production will be able to store their feed stock as it is processed.

A refiner always saves money by carefully planning chemical cleaning treatments with the service company engineer in advance. Improper scheduling could result in having several hundred men from labor pools waiting until a unit is finished. By proper planning, the refiner can eliminate unnecessary labor costs by having the necessary craft present in the right numbers, at the time they are needed.

Equipment Considerations. Giving the chemical cleaning contractor a detailed description of the equipment design and materials of construction is also important. Metallurgical considerations affect the choice of solvent to be used and the type of corrosion inhibitor included in the solvent. Many different types of alloys are now in use in refineries. With many possible combinations of dissimilar metals in a single piece of equipment, the solvent often provides an electrolyte which sets up an active corrosion cell.

For this reason, it is important for the cleaning contractor to know not only what metals are present in the equipment being cleaned, but also the relative surface areas of these metals. The severity of galvanic action in a given unit depends to a large extent on the relative areas of the anodic and cathodic areas. Knowing what metals

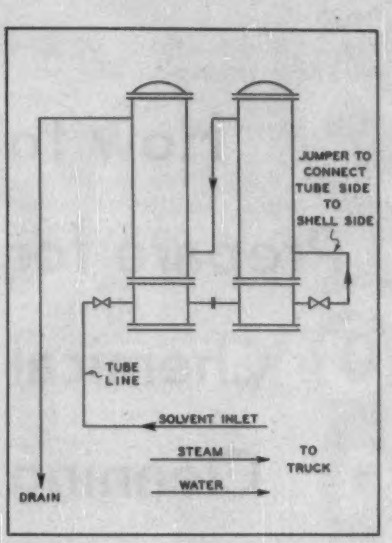


FIGURE 3—On exchanger train, a jumper connects the tube and shell sides.

are present, the contractor can choose an inhibitor that will also give good protection from galvanic corrosion.

The metals of which a given piece of equipment are constructed affect the choice of solvent to be used in cleaning it. For example, aluminum tube bundles are used in many refinery processes now. In some cases, test installations of only a few aluminum bundles are present. For example, a nest of exchangers containing 12 bundles might have only one aluminum bundle. Unless the service company personnel were aware of this, they might use an acid solvent that would destroy the aluminum bundle.

Even stainless steels require careful consideration when choosing the type of solvent to be used. Some types of stainless steel are subject to chloride cracking, and when adequate flushing facilities are not available, chloride-free solvents must be utilized for such cleaning jobs. Inhibited dilute sulfuric, sulfamic, and phosphoric acids are being used more frequently now in cleaning units containing stainless steel. When an entire system, including piping, is of stainless steel, 20-40 percent nitric acid can safely be used.

The metallurgy of reforming units is particularly tricky. They contain stainless steel, carbon steel, and even aluminum. The chrome-trimmed valves present in these units are often not resistant to solvents normally used in chemical cleaning. Because reformer designs are not standard, it is necessary for the refiner to tell the service company what metals are present in the

Planning for chemical cleaning prevents accidents such as acid solvent being dumped into a sewer containing sulfides.

Equipment can be protected from galvanic corrosion by judicious selection of a solvent that contains the proper inhibitor.

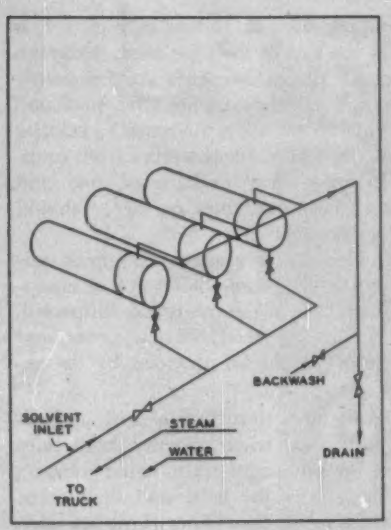


FIGURE 4—Valve system allows positive circulation through each condenser.

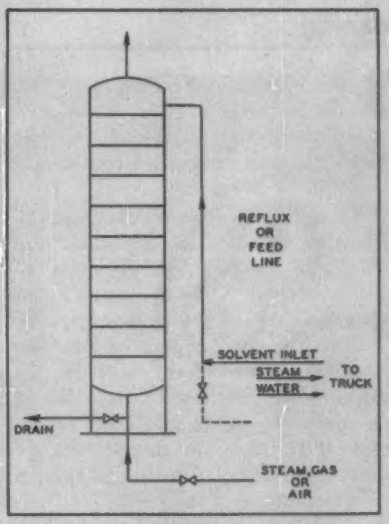


FIGURE 5—On towers, temporary piping ties-in the inlet and reflux lines.

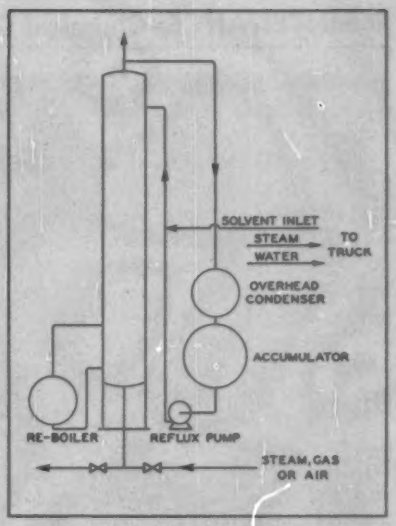


FIGURE 6—When cleaning a tower, it is filled with solvent and circulated.

reforming unit. All of these problems of dissimilar metals can be handled safely when the service company is aware of their presence.

Free-machining bolts or similar metals (for example SAE 1115) cannot be protected from acid attack, even by using inhibited acids. Such metals run from 0.16 to 0.23 percent sulfur content. Metallurgical tests show that these metals are readily etched and attacked by inhibited acids. Such attacks can be avoided by using steel bolts with low sulfur contents (from .02 to .06 percent), which resist inhibited acids. There is also some evidence that alloys of the 4140 class, sometimes specified for use in bolts or pressure vessels, are subject to failure when exposed to inhibited acids. Apparently, such failures are due to embrittlement, which is accelerated by a sulfur atmosphere, particularly by hydrogen sulfide.

Refinery equipment can be cleaned many times without necessarily weakening the structure. For example, there are records of high pressure boilers which have been cleaned as many as 24 times, with no ill effects.

Process Considerations. The chemical cleaning service company should be informed as to what manufacturing processes are conducted in each piece of equipment to be cleaned. This is necessary in order to provide for the most efficient cleaning, to prevent possible hazards to catalyst, product, or equipment, to prevent hazards to personnel, and to provide for safe disposal of spent solvents.

All types of refinery equipment can be chemically cleaned. However, such deposits as calcium sulfate, iron disulfide, cupric sulfide, and any polymerized or partially carbonized deposits are relatively difficult to remove. A list of the various kinds of refinery equipment that have been chemically cleaned is given in Table 1.

Proper sampling of scale deposits in a unit cannot be stressed too much. Often in the past, scale samples sent to a service company for analysis showed that the deposit could be easily removed, and the cleaning job was attempted. Following the treatment, it was frequently found that little benefit had resulted. Upon examination, the scale sample submitted to the company proved to be material that had washed out of the unit during a normal washing operation. A true sample of the scale to be removed would have been from the deposits remaining on the metal of the unit. Because more than 100 different solvents may be used in cleaning a refinery unit, it is extremely important to be sure that a good scale sample is obtained so that the proper solvent can be used.

A representative scale sample and the past history of the unit being cleaned are important from another viewpoint. Frequently hazards to personnel may result from cleaning a unit when the deposits are not of the type they are thought to be. The coolant side of refining equipment usually does not present toxic hazards. However, in cleaning the products side of all refining equipment it is necessary to exercise all precautions. Among the deposits found on the products side are compounds of sulfur, arsenic, antimony, phosphorous, and possibly selenium, tin, and tellurium. Any of these, when contacted by solvents, can generate toxic gases. Hydrogen sulfide and arsine are two examples of the toxic gases which might be generated.

If the sampling of scale deposits from the unit is not accurate, and if the past history of processes in the unit is not thoroughly discussed before cleaning is begun, serious consequences can result. As a precaution, in the cleaning of storage tanks, a service company automatically should operate on the assumption that at some time or other the tank had been in gasoline storage, and therefore contained tetraethyl lead deposits.

Cyanides are frequently formed in fluid catalytic cracking units and in the vapor recovery portions of such units. These deposits normally appear as ferro- or ferricyanides, and highly toxic hydrogen cyanide gas is formed when they are contacted by hydrochloric acid. If the service company is aware that these deposits are present, adequate safety precautions can be taken to minimize or eliminate this danger.

Arsenic, which may come from the acid or from the metal being cleaned, is another serious offender that must be carefully watched during refinery cleaning processes.

Gases generated during the cleaning

processes within a refinery are of two types, poisonous gases and merely irritating gases.

A serious fire hazard can be created if adequate precautions are not taken. For example, hydrogen sulfide, mixed with the right amount of air, can produce a fire. Such a hazard could occur when a tower containing hydrogen sulfide deposits is cleaned and air is used to agitate the solvent. In such a case, a safer gas (such as ethane) can be used to prevent this hazard.

Proper planning can minimize the danger of explosions also. For example, mixtures of chlorinated and alkaline solvents can produce explosions upon contact with each other. Conceivably, a unit that had contained one of these solvents could be cleaned, and if the second agent were added, the ingredients of an explosion would be present.

A further danger to be avoided is the contamination of either product or catalyst. Any metallic salt is poisonous to most catalysts used in reforming units. However, these catalysts have a tolerance limit. If the service company is told what the catalyst's tolerance limit is, it can keep residual concentrations of metallic salts within such limits. Also, in some tank cleaning operations, oil residues could be left which affect the color of gasoline. Certainly such contamination could be expensive if a large storage tank of gasoline were contaminated so that it could not pass a color test. By adequate discussion and planning beforehand, all such dangers of contamination can be avoided.

The nature of scale deposits and the unit's past history are important also from the viewpoint of disposing of spent solvents. Careful planning for such disposal is extremely important. It would be very unwise, for example, to dump hydrochloric acid into a phenol sewer, because of the resulting chlorophenols which could not be removed. If the water should later go into a municipal drinking supply, a serious problem would result.

Another hazard to be avoided is dumping solvent into a sewer which contains a scale that would produce a toxic gas upon contact by solvent. In the past, acid has sometimes been dumped into spent caustic sewers, producing deadly hydrogen sulfide gas. In one case, this gas backed up to the pumphouse, resulting in some lost-time days by personnel. Fortunately no fatality occurred.

Toxic gases should usually be vented to a flare, where they can be burned safely. Disposal of such gases by venting up a large smokestack or chimney is not always effective. If atmospheric conditions are unfavorable, the gas may settle back on the ground, creating serious hazards.

Solid materials removed from flare lines by mechanical pigs also present a disposal problem. Because these deposits may ignite upon contact with air, they should be buried or burned.

Piping To Units. Preparing for chemical cleaning of equipment also involves considering piping to be installed. Solvents are normally introduced in units from the bottom. Such filling minimizes the danger of air or vapor lock. In some equipment, such as towers, it is advantageous to introduce the solvent through the reflux line and down through the unit.

Some typical piping arrangements for various types of equipment appear in Figures 1 to 6. Figure 1 shows a basic piping diagram for cleaning tube heat exchange units, one above the other. Normally the refiner furnishes a portion of the inlet line, the outlet line, and a vent or sampling point. A suitable drain must also be installed. The only problem likely to occur in piping such as shown in Figure 1 is in the size of the pipe used. Although small drains or vents are frequently employed, they are not efficient. Small lines do not allow the required velocity to flush insoluble materials from units. In most heat exchangers, one and one-half inch lines or larger should be installed.

Figure 2 is a suggested piping system for the same basic type of equipment when the units are dispersed. Again, the inlet, outlet, vents and drain should be provided by the refiner.

Figure 3 illustrates a hook-up normally used when cleaning both sides of an exchanger train, using jumpers to connect the tube and shell sides. Here again the refiner furnishes inlet, outlet, drain, vent and jumper lines.

In Figure 4 a schematic drawing of multiple units manifolded together is shown. The valve system permits positive circulation through each condenser.

A schematic hook-up drawing for cleaning a scrubber is shown in Figure 5. On scrubbers or towers, normally the inlet line is tied in with temporary piping to the reflux or feed line. The solvent is introduced through this line, cascading down through the units and removing the bulk of deposits. During this operation, the drain valve is left open so that corrosive material is carried out. In the case of large towers, the cleaning treatment consists entirely of such cascading operations. On smaller towers, cascading is continued until checks on solvent concentration show that the solvent is relatively clear of scale deposits and that its concentration has reached three or four percent. The drain valve is then closed and the unit is filled. Usually a steam, gas, or air connection is then tied into the bottom and is used to agitate the solvent remaining in the unit.

Figure 6 is a suggested hook-up for cleaning a tower and its pertinent units in a single operation. Here the unit is simply filled with solvent, which is then circulated until deposits are completely removed.

In cleaning tanks, piping is usually at a minimum. Ordinarily it is necessary only to remove one inspection door. This, of course, means that the sludge must be below door level. The only piping which the refiner should furnish is a line for pumping out material removed from the tank. # #

About the Author

Ivan R. Bielek was graduated from the University of Pittsburgh in 1941 with a B.S. degree in petroleum engineering. After serving in the Army during World War II, he was employed by the Corps of Engineers. In 1947 he joined Dowell, Inc., where he has served as service engineer, area engineer, and district area manager. In 1957 he was named district operations manager in Cleveland. Bielek has a broad background in industrial cleaning, and is a specialist in solving the problems of cleaning refinery equipment.

FIGURE 1—Outdoor switch rack houses explosion-proof starters for heater equipment in background.

Classifying hazard areas is the key to . . .

Explosion-Proof Electrical Systems

Here's how one company went about it and came up with an excellent example of a well engineered system.

Russell P. Northrup
Crouse-Hinds Company
Syracuse, New York

TIDEWATER OIL COMPANY'S recently completed Delaware Refinery embodies an excellent example of a well-engineered, well-constructed electrical system, largely explosion-proof. The construction of this mammoth petroleum processing center called for considerable planning and ingenuity to determine the existence, degree and extent of the refinery's hazardous areas.

This article shows how various areas were classified, then equipped, in order to minimize the hazard of explosive flammable substances being processed or stored throughout the refinery.

Hazardous Areas. Classification of hazardous areas at Tidewater's Dela-

FIGURE 2—Control board in crude tankage area controls tank flow lines.

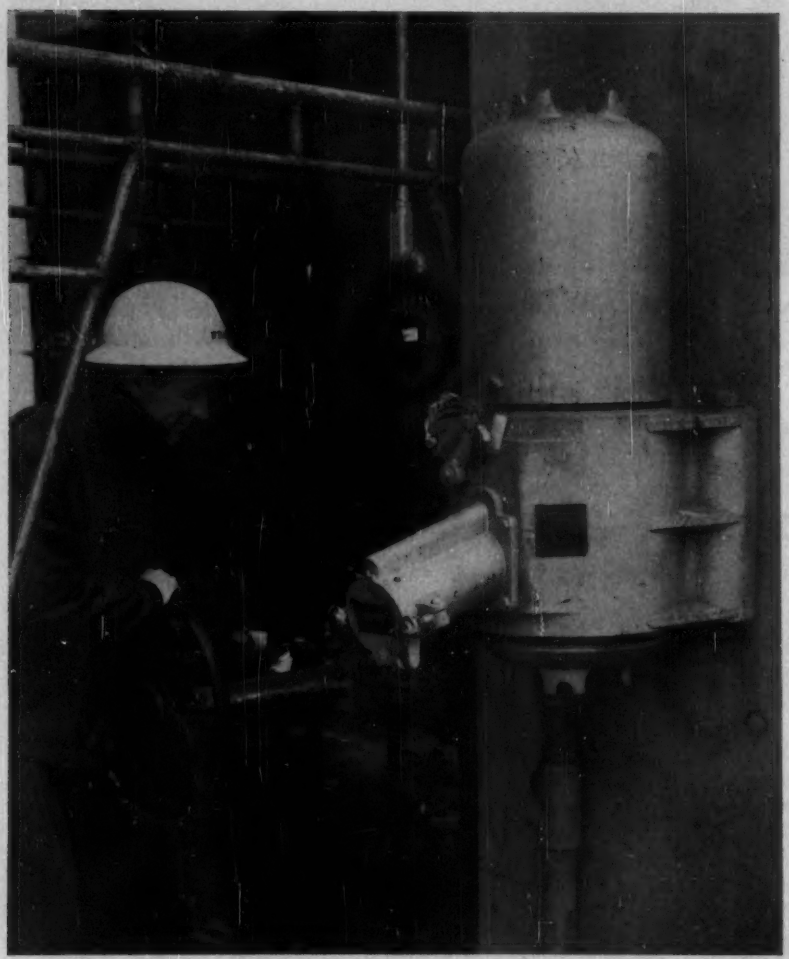


FIGURE 3—Large circuit breaker and interlocked receptacle, at base of reactor, is a threaded type enclosure.

ware Refinery was based upon the provisions of the National Electrical Code. It is interesting to note that engineers at Tidewater and C F Braun & Company, using the code and their previous engineering experience with refinery explosion-proofing problems, came up in 1953 with a classification that later closely paralleled the recommendations of RP-500, the American Petroleum Institute's recommended practice for classifying hazardous refinery areas.

Flammables. Depending upon the degree of temperature, most flammable liquids are volatiles; they evaporate quickly and vaporize constantly. Their vapors cannot be seen by the naked eye and, generally being heavier than air, they seek the lowest grade level. If and when they escape, they tend to flow downward into low spots, hover about underground cavities, billow in poorly-ventilated areas, thereby creating hazardous zones.

The Code Class I, Group D category includes most of the heavier than air flammables: Gasoline, hexane, naphtha, benzene, butane, propane, alcohol, acetone, benzol, lacquer solvent vapors, or natural gas.

Commonly processed in refineries, most of these substances are produced or stored at Tidewater but under conditions that drastically minimize their volatile characteristics.

Three essential simultaneous conditions create a hazardous area: (1) vapors escaping in sufficient quantity, (2) a flammable mixture of vapor and air, and (3) a source of ignition. Natural or mechanical ventilation frequently reduces the likelihood of a flammable concentration of vapor (if such should escape) and air collecting in a confined area. This means that varying degrees of hazard may be found in different parts of a refinery. Areas that cause trouble are those where vapors can escape in sufficient quantity to ignite. The code defines two types of hazard for these locations:

Division 1 locations are considered normally, frequently, intermittently or periodically hazardous. Division 2 locations are classified as abnormally and infrequently hazardous.

Since the code describes as hazardous, Division 1 areas where the presence of flammable hydrocarbons are normal, all enclosed buildings, underground pits and manholes within

these areas at Tidewater were generally classified as Class I, Division 1 locations. Outdoor and other freely-ventilated areas were classified as Class I, Division 2. Besides these categories, a third or nonhazardous classification was made to include all other refinery areas not encompassed by Division 1 or 2.

Because each major processing operation is a complete physical unit, electrical control devices were located at a central point, at or near the unit. Pressurized switch houses were used in some areas, explosion-proof switch racks in others (Figure 1). In concentrated areas, such as the process units, switch houses were built simply because they were more practical for housing the maze of electrical control equipment. However, in a remote area like a tank farm where only three or four motors might be grouped, explosion-proof switch racks were installed to meet Class I, Division Z. requirements.

Areas remote from hazardous sources of gas were classified as nonhazardous (Figure 2). In addition, all control houses and switch houses were pressurized and classified as non-hazardous.

Switch Houses. Rather than install outdoor switch-gear at the processing area, it was foun dto be more economical to install indoor switchgear and build switch houses which could shelter instrumentation and control panels—as well as provide indoor comfort for maintenance and operating personnel throughout the big plant. There are 14 switch houses, most of them containing both 2400-volt and 480-volt substations, plus several 2300- and 440-volt motor control assemblies. The transformers are installed outdoors and are connected to the indoor switchgear by bus ducts. Because of hazardous vapor conditions that may occasionally exist in some areas of the refinery, vapor seals were built into all ducts entering the switch houses.

The houses were pressurized with clean, pure air drawn into them through a stack extending well above the roof. Cable vault entrances were gasketed and cable ducts held at a pressure higher than the switch houses. All of the petroleum lines in the refining area are above ground, so there is no hazard from underground leaks.

Every precaution was taken to reduce explosion hazards to a minimum. Cooling fan motors on the outdoor power transformers are of explosion-proof design with top oil thermometer control. The test switch for the fans on each transformer is also of the explosion-proof type.

FIGURE 4—These pump motor pushbutton stations control the flow of product from the process area to the tank farms.

Explosion-Proofing. Design and construction of explosion-proof electrical enclosures are based on three physical conditions: (1) strength to withstand the force of internal explosions which may occur when flammable vapors enter the enlosure, (2) flametight joints at enclosure openings, such as covers or operating shafts, and (3) surface temperatures safely below the ignition temperature of flammable vapors.

Required strength for an explosion-proof enclosure is determined by actual explosion tests conducted by Underwriters' Laboratories. By exerting hydrostatic pressures four times the explosion pressure on the enclosures, UL achieves a four-to-one safety factor. Thus, an enclosure which develops a maximum explosion pressure of 100 psi, when tested with gasoline vapor, must withstand 400 psi to qualify for UL listing for use at Class I, Group D locations.

There are two types of enclosure joints, threaded or flat. Threaded joint construction provides maximum safety with minimum maintenance. It is practical for all smaller and many larger enclosures which are designed to permit the use of circular cover opening (Figure 3). It also is practical for all enclosure operating shafts except where push-pull action or continuous rotation are required. Maintenance of threaded joint explosion-proof enclosures calls for only normal care in keeping covers tight; threads should be clean and lubricated to enable covers to be easily removed.

For rectangular openings, on both large and small explosion-proof enclosures, flat joint construction is employed (Figure 4). Similarly, journal bearing construction normally is used on push-pull or rotating operating shafts. Usually, flat joints covers are bolted in place. To be sure that all bolts are tight, the cover joint clean and free of corrosion, and that foreign matter does not become lodged between the enclosure's cover and body, flat joint covers require extreme care in installation and maintenance.

Operating temperature is not a problem, except when the explosion-

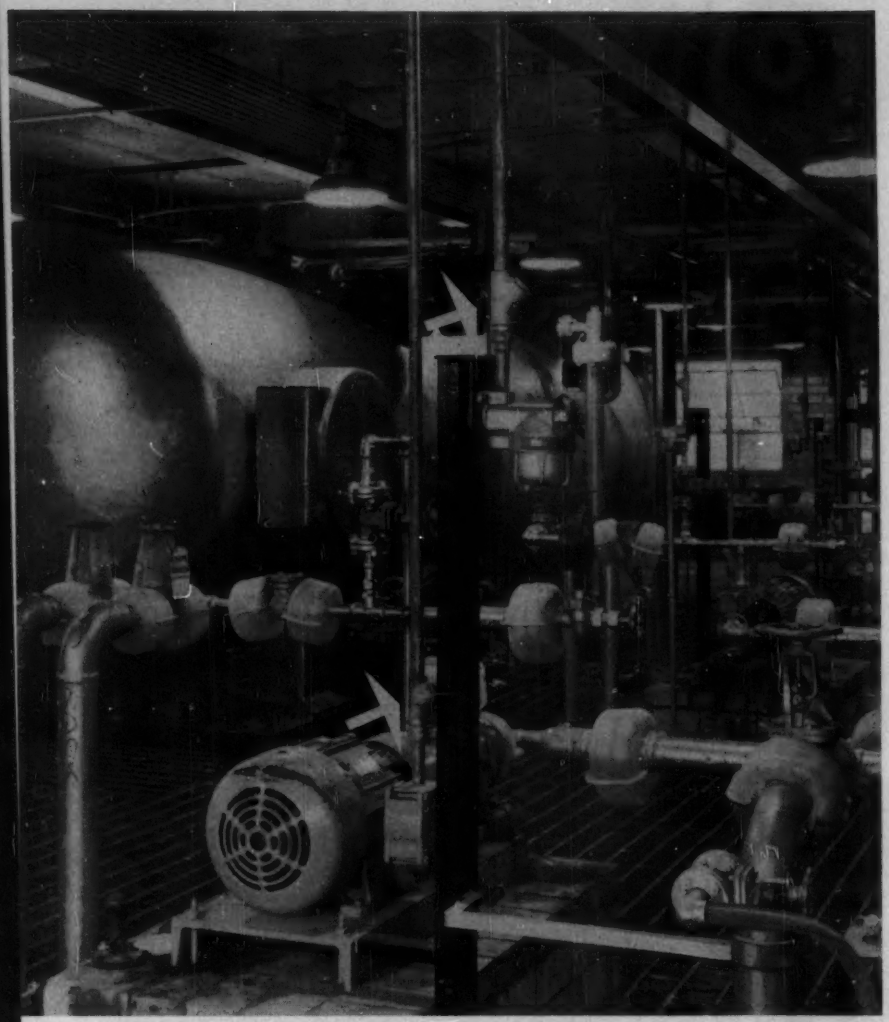


FIGURE 5—Drain and inspection seals eliminate water condensed in the conduit.

proof device produces heat such as, for example, a lighting fixture. Explosion-proof lighting fixtures are tested by Underwriters' Laboratories and listed for specific hazards. As a result, explosion-proof fixtures can be applied in hazardous areas of the listed National Electrical Code Class and Groups without further engineering study.

When non-explosion-proof fixtures are used in Class I, Division 2 locations, the National Electrical Code requires that operating temperature of the lamp must not exceed 80 percent of the ignition temperature of the flammable vapor. Accordingly, information on operating temperatures of vaportight fixtures used at Tidewater was obtained from the manufacturer. Because the correct combination of fixture, reflector, and lamp was selected for each location at Tidewater, maintenance personnel should not increase lamp sizes without first assuring themselves that the critical temperatures of these fixtuers will not be exceeded.

Wiring and Sealing. All transformers at Tidewater have sudden pressure relays with conduit wiring to and from the explosion-proof terminal box. All wiring in hazardous areas is in rigid steel conduit, as the National Electrical Code specifies. All joints of the conduit are tight, with at least five threads fully engaged.

Rigid metal conduit was used for wiring above the hazardous areas and for underground wiring, unless the conduit was buried deeper than two feet; in that case non-metallic conduit or cable was used.

Seals were used to limit an explosion to a single explosion-proof enclosure, preventing passage of gases, vapors or flames from one section of conduit to another. Seals stop precompression or "pressure piling"—the buildup of terrific pressure in the conduit system caused by successive explosions. In hazardous areas, seals are located in conduit runs that: enter an explosion-proof enclosure housing arcing or high temperature equipment; are two inches in size, or larger, entering enclosures, housing terminals, splices or taps; or leave a Division 1 area or pass from a Division 2 hazardous area to a non-hazardous location. In addition, each seal was placed within 18 inches of the explosion-proof device it isolates.

Joints in a conduit system and its components seldom are tight enough to prevent "breathing" and water accumulation. Alternate changes in temperature and barometric pressure cause "breathing"—the entry and circulation of air throughout the conduit. Moisture in the air condenses when temperature readings fall, thereby causing water to collect at the base of vertical conduit runs and equipment enclosures. To eliminate this condition, drain and inspection seals, equipped with explosion-proof, automatic drains, bleed off the water (Figure 5). ##

About the Author

Russell P. Northrup is vice-president—Engineering, at Crouse-Hinds Company, Syracuse, New York. After earning B.S. degree in electrical engineering at Syracuse University, he joined Crouse-Hinds in 1935 and was assigned to Houston as a sales engineer. He became assistant to the general sales manager in 1947 and commercial vice-president in 1951. Just named to his present assignment, Northrup is a member of the American Petroleum Institute's Division of Refining and the Petroleum Electric Supply Association.

Why Prefab Insulation Cuts Costs

From the development of standards to the actual cutting, assembly and application of prefabricated insulation, one of the first questions is economics.

Here are the answers.

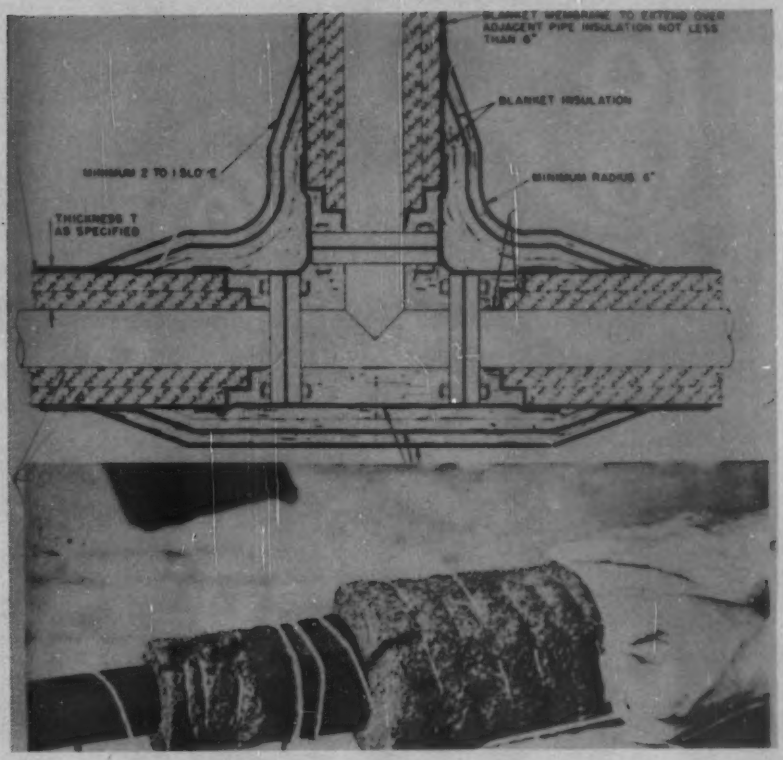

BLANKET MEMBRANE TO EXTEND OVER ADJACENT PIPE INSULATION NOT LESS THAN 6"
BLANKET INSULATION
MINIMUM RADIUS 6"
THICKNESS T AS SPECIFIED

FIGURE 1—Old style, field installations were hand-fitted jobs.

W. C. Turner, Union Carbide Chemicals Company, South Charleston, W. Va.

PREFABRICATION of insulation provides a means to obtain more economical and more quickly installed insulation of better quality. In addition, for maintenance, it is possible to remove and replace fitting covers, thus effecting considerable savings.

Each thermal insulation has its own individual properties. These properties may be broken down into three major classifications: (1) Thermal properties, (2) chemical properties and (3) physical properties.

The insulation selected for any given insulation should be the insulation which has properties which best fulfill the requirements. However, some requirements are so severe that it is necessary to use more than one insulation to fulfill the demands. This leads to the use of combinations of insulation on a single installation.

The use of diatomaceous earth insulation as an inner layer under 85 percent magnesia has been a practice of long standing. This combination was devised to take advantage of the thermal properties of each material. The diatomaceous earth, which can withstand higher temperature than magnesia, was used as the first thermal barrier around pipe and vessels whose temperature limits exceeded that of magnesia. Magnesia, which has a lower conductivity value than diatomaceous earth, was used as an outer layer so as to obtain better efficiency.

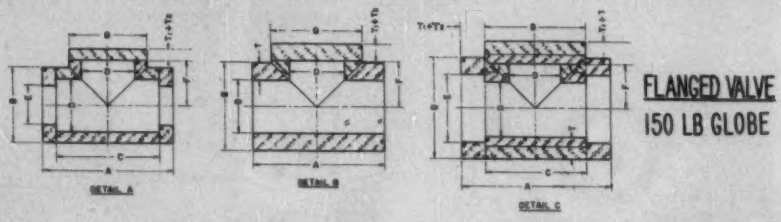
The chemical properties of insulation sometimes dictate the combination of materials that should be used. Many times an inner layer of insulation is selected because it will not cause corrosion of the surface to which it is applied. The outer layer is then selected which most nearly satisfies the conditions it is to fulfill.

Physical properties may indicate that multiple types of insulations should be used. One type of installation frequently encountered is where the inner layer is selected to be soft and resilient to absorb vibration, while the outer layer is hard and rigid to withstand mechanical abuse. In addition, protection of low temperature insulation from possible fire exposure may necessitate more than one type insulation be used on pipes and vessels.

Standardization. Because of these reasons, it became necessary to investigate the possibility of standardization of sizes, so as to make possible the combined use of various materials. This investigation was started in January of 1941. At that time it was found that five different thickness sizing systems were used in the industry. These were:

- Combination covering sizes, used for diatomaceous earth and 85 percent magnesia combinations.
- The ½-inch increment system, wherein the thicknesses increased in even ½-inches.
- Standard and double standard thicknesses.
- Ice water, brine, and heavy brine sizes, wherein thickness was based on a specific operating temperature range.
- Thickness system based on number of laminations or plies.

The then existing practices of producing pipe insulation, to obtain



NOMINAL PIPE SIZE	INSULATION THICKNESS, T		CONST. DETAIL	PIPE INSULATION						BLOCK				A	B	C	D	E	F	OUTSIDE AREA SQ. FT.
	NOM.	ACTUAL	NO.	FIRST LAYER	NOM. THICK.	L.F.	SECOND LAYER	NOM. THICK.	L.F.	T_1	S.F.	T_2	S.F.							
2½	1.0	0.96	A	6	1.5	1.62	--	--	--	2.5	2.10	--	--	18.00	9.63	13.00	6.63	4.50	6.50	6.09
	1.5	1.44	A	6	1.5	1.62	--	--	--	2.5	2.10	--	--	18.00	9.63	13.00	6.63	5.56	6.50	6.04
	2.0	2.00	B	6	2.0	2.12	--	--	--	3.0	0.04	--	--	19.00	10.75	--	6.63	6.63	6.50	6.97
	2.5	2.50	C	6	2.5	1.62	--	--	--	3.0	3.00	--	--	19.00	11.75	13.00	6.63	7.63	6.50	8.27
	3.0	3.00	C	6	3.0	1.62	--	--	--	3.0	3.52	--	--	19.00	12.75	13.00	6.63	8.63	6.50	8.17
	3.5	3.63	C	6	3.5	1.62	--	--	--	3.5	4.70	--	--	20.00	14.00	13.00	6.63	9.63	6.50	9.78
	4.0	4.13	C	6	4.0	1.62	--	--	--	4.0	5.33	--	--	21.00	15.00	13.00	6.63	10.75	6.50	10.50
	4.5	4.56	C	6	2.0	1.62	10	2.5	1.62	2.0	6.00	2.5	6.00	22.00	16.00	13.00	6.63	11.75	6.50	11.64
	5.0	5.06	C	6	2.5	1.62	11	2.5	1.62	2.5	6.75	2.5	6.75	23.00	17.00	13.00	6.63	12.75	6.50	12.86
	5.5	5.56	C	6	2.5	1.62	12	3.0	1.62	2.5	7.50	3.0	7.50	24.00	18.00	13.00	6.63	13.00	6.50	14.14
	6.0	6.05	C	6	3.0	1.62	12	3.0	1.62	3.0	8.35	3.0	8.35	25.00	19.00	13.00	6.63	15.00	6.50	15.45
	6.5	6.55	C	6	3.0	1.62	12	3.5	1.62	3.0	9.00	3.5	9.00	26.00	20.00	13.00	6.63	16.00	6.50	16.03
	7.0	7.05	C	6	3.5	1.62	13	3.5	1.62	3.5	10.00	3.5	10.00	27.00	21.00	13.00	6.63	17.00	6.50	16.27
	7.5	7.55	C	6	4.0	1.62	14	3.5	1.62	4.0	11.10	3.5	11.10	28.00	22.00	13.00	6.63	18.00	6.50	19.77
3	1.0	1.50	A	7	1.5	1.85	--	--	--	2.5	2.52	--	--	20.00	10.75	15.00	7.63	5.56	7.25	7.27
	1.5	1.50	A	7	1.5	1.85	--	--	--	2.5	2.52	--	--	20.00	10.75	15.00	7.63	6.63	7.25	7.12
	2.0	2.00	B	7	2.0	2.35	--	--	--	3.0	1.00	--	--	21.00	11.75	--	7.63	7.63	7.25	8.18
	2.5	2.50	C	7	2.5	1.85	--	--	--	3.0	3.52	--	--	21.00	12.75	15.00	7.63	8.63	7.25	8.76
	3.0	3.13	C	7	3.0	1.85	--	--	--	3.0	4.70	--	--	21.00	14.00	15.00	7.63	9.63	7.25	9.59
	3.5	3.63	C	7	3.5	1.85	--	--	--	3.5	5.33	--	--	22.00	15.00	15.00	7.63	10.75	7.25	10.04
	4.0	4.13	C	7	4.0	1.85	--	--	--	4.0	5.33	--	--	23.00	16.00	15.00	7.63	11.75	7.25	11.84
	4.5	4.56	C	7	2.0	1.85	11	2.5	1.85	2.0	6.00	2.5	6.00	24.00	17.00	15.00	7.63	12.75	7.25	13.05
	5.0	5.05	C	7	2.5	1.85	12	2.5	1.85	2.5	6.75	2.5	6.75	25.00	18.00	15.00	7.63	14.00	7.25	14.26
	5.5	5.55	C	7	2.5	1.85	12	3.0	1.85	2.5	7.50	3.0	7.50	26.00	19.00	15.00	7.63	15.00	7.25	15.66
	6.0	6.05	C	7	3.0	1.85	12	3.0	1.85	3.0	8.35	3.0	8.35	27.00	20.00	15.00	7.63	16.00	7.25	17.05
	6.5	6.55	C	7	3.0	1.85	12	3.5	1.85	3.0	9.00	3.5	9.00	28.00	21.00	15.00	7.63	17.00	7.25	18.49
	7.0	7.05	C	7	3.5	1.85	13	3.5	1.85	3.5	10.00	3.5	10.00	29.00	22.00	15.00	7.63	18.00	7.25	19.98
	7.5	7.54	C	7	4.0	1.85	14	3.5	1.85	4.0	11.10	3.5	11.10	30.00	23.00	15.00	7.63	19.00	7.25	20.95
4	1.0	1.50	A	8	1.5	2.19	--	--	--	2.5	3.00	--	--	23.00	12.75	18.00	8.63	6.63	8.25	8.98
	1.5	1.50	A	8	1.5	2.19	--	--	--	2.5	3.00	--	--	23.00	12.75	18.00	8.63	7.63	8.25	8.83
	2.0	2.00	B	8	2.0	2.69	--	--	--	3.0	1.18	--	--	24.00	13.75	--	8.63	8.63	8.25	9.87
	2.5	2.63	C	8	2.5	2.19	--	--	--	3.0	4.70	--	--	24.00	14.00	18.00	8.63	9.63	8.25	10.81
	3.0	3.13	C	8	3.0	2.19	--	--	--	3.0	5.33	--	--	24.00	15.00	18.00	8.63	10.75	8.25	11.50
	3.5	3.63	C	8	3.5	2.19	--	--	--	3.5	6.00	--	--	25.00	16.00	18.00	8.63	11.75	8.25	12.71
	4.0	4.13	C	8	4.0	2.19	--	--	--	4.0	6.75	--	--	26.00	17.00	18.00	8.63	12.75	8.25	13.98
	4.5	4.55	C	8	2.0	2.19	12	2.5	2.19	2.0	7.50	2.5	7.50	27.00	18.00	18.00	8.63	14.00	8.25	15.24
	5.0	5.05	C	8	2.5	2.19	14	2.5	2.19	2.5	8.35	2.5	8.35	28.00	19.00	18.00	8.63	15.00	8.25	16.20
	5.5	5.55	C	8	2.5	2.19	14	3.0	2.19	2.5	9.00	3.0	9.00	29.00	20.00	18.00	8.63	16.00	8.25	17.93
	6.0	6.05	C	8	3.0	2.19	15	3.0	2.19	3.0	10.00	3.0	10.00	30.00	21.00	18.00	8.63	17.00	8.25	19.18
	6.5	6.55	C	8	3.0	2.19	15	3.5	2.19	3.0	11.10	3.5	11.10	31.00	22.00	18.00	8.63	18.00	8.25	21.19
	7.0	7.04	C	8	3.5	2.19	16	3.5	2.19	3.5	11.93	3.5	11.93	32.00	23.00	18.00	8.63	19.00	8.25	22.71
	7.5	7.54	C	8	4.0	2.19	17	3.5	2.19	4.0	13.00	3.5	13.00	33.00	24.00	18.00	8.63	20.00	8.25	24.41
5	1.0	1.50	A	9	1.5	2.48	--	--	--	2.5	3.52	--	--	26.00	12.75	21.00	9.63	7.63	8.75	10.61
	1.5	1.50	A	9	1.5	2.48	--	--	--	2.5	3.52	--	--	26.00	12.75	21.00	9.63	8.63	8.75	10.43
	2.0	2.13	B	9	2.0	2.98	--	--	--	3.0	1.56	--	--	27.00	14.00	--	9.63	9.63	8.75	11.68
	2.5	2.63	C	9	2.5	2.48	--	--	--	3.0	5.33	--	--	27.00	15.00	21.00	9.63	10.75	8.75	12.64
	3.0	3.13	C	9	3.0	2.48	--	--	--	3.0	6.00	--	--	27.00	16.00	21.00	9.63	11.75	8.75	13.41
	3.5	3.63	C	9	3.5	2.48	--	--	--	3.5	6.75	--	--	28.00	17.00	21.00	9.63	12.75	8.75	14.78
	4.0	4.13	C	9	4.0	2.48	--	--	--	4.0	7.50	--	--	29.00	18.00	21.00	9.63	14.00	8.75	16.05
	4.5	4.55	C	9	2.0	2.48	14	2.5	2.48	2.0	8.35	2.5	8.35	30.00	19.00	21.00	9.63	15.00	8.75	17.53
	5.0	5.05	C	9	2.5	2.48	15	2.5	2.48	2.5	9.00	2.5	9.00	31.00	20.00	21.00	9.63	16.00	8.75	18.89
	5.5	5.55	C	9	2.5	2.48	15	3.0	2.48	2.5	10.00	3.0	10.00	32.00	21.00	21.00	9.63	17.00	8.75	20.49
	6.0	6.06	C	9	3.0	2.48	16	3.0	2.48	3.0	11.10	3.0	11.10	33.00	22.00	21.00	9.63	18.00	8.75	22.15
	6.5	6.54	C	9	3.0	2.48	16	3.5	2.48	3.0	11.93	3.5	11.93	34.00	23.00	21.00	9.63	19.00	8.75	23.71
	7.0	7.04	C	9	3.5	2.48	17	3.5	2.48	3.5	13.00	3.5	13.00	35.00	24.00	21.00	9.63	20.00	8.75	25.46
	7.5	7.54	C	9	4.0	2.48	18	3.5	2.48	4.0	14.20	3.5	14.20	36.00	25.00	21.00	9.63	21.00	8.75	27.28

FIGURE 2—A typical fabrication data sheet includes all the information needed to make an insulation fitting.

thicknesses from 1 inch to 3 inches, required stocking a total of 600 sizes. Regardless of the great number of sizes then being produced, one type of insulation could not be used in combination with another because they would not always fit.

In addition to the inability to select materials for their best usage, the old confused systems did not lend themselves to the proper selection of thickness, because of the large jumps in thicknesses available. For example, on 12-inch IPS, Standard Thickness equaled 1.5-inch and Double Standard Thickness equaled 3.0 inch. Thicknesses of 2.0 inches and 2.5 inches were not available except on special order. Another case could be cited in the low temperature insulation sizes, where ice water thickness equaled 1.5-inch and brine thickness equaled 3.0-inch. In each case, if requirements dictated that 2.0 inches of insulation was needed, it was necessary to use 3.0 inches, thus wasting money.

Stocking all the various sizes of insulation was extremely bulky and expensive, and even shipping was a problem, as there was no way of standardizing packaging.

All factors pointed to the need for a better system of standardizing and sizing pipe insulation, to eliminate the costly waste and confusion. The problem presented indicated that insulation must fit insulation as well as pipe. It was reasonable to conclude that the only manner in which this could be acomplished was to make the outside diameter of each piece of insulation equal to the outside diameter of some standard IPS. On this basic thought, the Dimensional Standards were developed.

This system of Dimensional Standards was presented to all manufacturers of insulation in 1943. Within a few months, one company produced insulation sized in accordance with this system of dimensions. During the intervening years most of the manufacturers of insulation have adopted the Dimensional Standards. This standard has also been adopted by the U. S. military services, and is called for under Military Specification MIL-1-2781B.

Dimensional Standards. The Dimensional Standard system provides great flexibility in the choice of thickness. The actual thickness of any given pipe insulation is the difference between two outside diameters of pipe insulation (minus clearance). These thicknesses are based on making the insulation as close as is feasible to 1.0 inch, 1.5 inches, 2.0 and 2.5 inches thicknesses. By selecting one, or nesting two or more coverings, it is possible to obtain from 1 inch to 10 inches (or greater) thickness, in increments of one-half inch. To obtain all these thicknesses for ½ inch IPS to 30 inches IPS requires ony 118 individual sizes. These sizes are listed in Table 1.

Due to properties of materials, some insulations must have more clearance than others. In general, all hot insulations must have more clearance around pipe than cold insulation. For these reasons, thicknesses are given are approximate. There are slight variations in thicknesses of various manufactured materials. As these variations are small, they can be ignored, because the mathematical error in the calculation of heat transfer, in most instances, is much greater than these differences in thickness.

The use of cellular glass insulation

made it necessary to change methods of application. Because of its rigidity, this insulation had to be accurately cut and fit for a satisfactory installation. Since it is necessary to use power equipment for accurate cutting, dimensions for shop fabrication had to be provided..

No effort had been made in this direction previous to this time, because low temperature installations consisted of blanket insulation wrapped around fittings in one inch thick layers, held in place with twine and tape. High temperature fittings were installed using narrow sections of block (lagging) wired in place. A coat of insulation cement was applied over the block to level the exterior surface, fill the voids and provide a smooth even surface.

Dimensions were not needed because these were field installed and hand fitted jobs. A typical, old style, field installed fitting is shown in Figure 1.

Standardization of pipe insulation had been a problem, but a small one compared to the task of standardizing fitting covers. The total number of covers required for fittings, flanges, and valves, from 125 to 1500 PSI pressures, and from 1 inch to 7½ inches thickness of insulation, is approximately 2250. To make prefabrication practical, it was necessary to determine the dimensions for all these sizes. Therefore, a manual of dimensional standards for valve, fitting, and flange covers was compiled.

The standardizing of pipe insulation made it possible to devise a practical system of prefabrication, because the outside diameter of the covering is an iron pipe size, and the inner dimension of any covering always fits over an iron pipe size. Basically, all flanged fitting covers were designed to fit over the fittings to be insulated and the adjacent pipe insulation. In most installations, the straight pipe insulation is insulated before flanged fitting covers are insulated. Therefore, covers which fit over the adjacent pipe insulation lend themselves to this installation sequence. This type of installation has another advantage in that the overlapping insulation can function as a slip joint and act as an expansion and contraction joint.

Some difficulty was experienced in designing covers for valves because the height of the bonnet flange and the bonnet diameter varies with the manufacturer, although most valves do have standard face to face dimensions. By listing the dimensions of a large number of manufacturer's valves, a set of dimensions was derived which would fit the largest valve of a particular series and type. As valve stems and packing glands differ with the manufacturer, the prefabricated fitting was designed to be made with a blank disk to be cut and fitted around the valve stem by the field insulator.

In tabulating this information into useful form, other information was included as an aid for billing and estimating. For example, on data sheets for each particular valve size and thickness of insulation, there is given the size of the standard pipe covering and linear feet required, square feet of block necessary, and the outside surface area of the fitting. Typical data sheet for valves is shown in Figure 2. Typical fittings made of cellular glass are shown in Figure 3.

FIGURE 3—Cellular glass, when cut and glued, makes ideal insulation fittings.

Prefabricated Insulation. The shop equipment to produce prefabricated insulation is basically tools used by the carpenter which are adapted for cutting insulation. Two methods are normally used for fabricating insulation—they are, by saw cutting, or abrasive grinding.

Saw cutting is generally done by a band saw. The band saws for most insulations operate at low speed, with a blade speed of approximately 1000 feet per minute. The blade most used is a 1 inch by 0.035 flexible back, 3 pitch, raker-tooth, chrome-plated blade.

Grinders used are not standard tools and are, therefore, made to fulfill the requirements of the particular shop where they are used.

After fabrication, the insulation must be cemented together. Low temperature insulation is generally cemented together with hot asphalt.

TABLE 1

Basic Thickness—Insulation Thickness Standard

Pipe	1" Nominal		1½" Nominal		2" Nominal		2½" Nominal	
I.P.S.	O.D. Inches	Approx. Thick.	O.D. Inches	Approx. Thick.	O.D. Inches	Approx. Thick.	O.D. Inches	Approx. Thick.
⅛	0.840	1.02	2.875	1.56	4.000	2.06	5.000	2.87	6.625
¼	1.050	.91	2.875	1.46	4.000	1.96	65.000	2.75	6.626
1	1.315	1.09	3.500	1.59	4.500	2.12	5.563	2.66	6.625
1¼	1.660	.91	3.500	1.66	5.000	1.94	5.563	2.47	6.625
1½	1.900	1.03	4.000	1.53	5.000	2.32	6.626	2.84	7.625
2	2.375	1.06	4.500	1.59	5.563	2.12	6.626	2.62	7.625
2½	2.875	1.06	5.000	1.87	6.625	2.37	7.625	2.87	8.625
3	3.500	1.03	5.563	1.56	6.625	2.06	7.625	2.56	8.625
3½	4.000	1.30	6.625	1.81	7.625	2.31	8.625	2.78	9.625
4	4.500	1.06	6.625	1.56	7.625	2.03	8.625	2.56	9.625
4½	5.000	1.30	7.625	1.81	8.625	2.31	9.625	2.86	10.750
5	5.563	1.03	7.625	1.53	8.625	2.03	9.625	2.56	10.750
6	6.625	1.00	8.625	1.50	9.625	2.03	10.750	2.53	11.750
7	7.625	...	.....	1.52	10.750	2.03	11.750	2.53	12.750
8	8.625	...	.....	1.52	11.750	2.03	12.750	2.68	14.000
9	9.625	...	.....	1.52	12.750	2.16	14.000	2.66	15.000
10	10.750	...	.....	1.59	14.000	2.09	15.000	2.60	16.000
11	11.750	...	.....	1.59	15.000	2.09	16.000	2.62	17.000
12	12.750	...	.....	1.59	16.000	2.09	17.000	2.62	18.000
14	14.000	...	.....	1.50	17.000	2.00	18.000	2.50	19.000
15	15.000	...	.....	1.50	18.000	2.00	19.000	2.50	20.000
16	16.000	...	.....	1.50	19.000	2.00	20.000	2.50	21.000
17	17.000	...	.....	1.50	20.000	2.00	21.000	2.50	22.000
18	18.000	...	.....	1.50	21.000	2.00	22.000	2.50	23.000
19	19.000	...	.....	1.50	22.000	2.00	23.000	2.50	24.000
20	20.000	...	.....	1.50	23.000	2.00	24.000	2.50	25.000
21	21.000	...	.....	1.50	24.000	2.00	25.000	2.50	26.000
22	22.000	...	.....	1.50	25.000	2.00	26.000	2.50	27.000
23	23.000	...	.....	1.50	26.000	2.00	27.000	2.50	28.000
24	24.000	...	.....	1.50	27.000	2.00	28.000	2.50	29.000
25	25.000	...	.....	1.50	28.000	2.00	29.000	2.50	30.000
26	26.000	...	.....	1.50	29.000	2.00	30.000	2.50	31.000
27	27.000	...	.....	1.50	30.000	2.00	31.000	2.50	32.000
28	28.000	...	.....	1.50	31.000	2.00	32.000	2.50	33.000
29	29.000	...	.....	1.50	32.000	2.00	33.000	2.50	34.000
30	30.000	...	.....	1.50	33.000	2.00	34.000	2.50	35.000

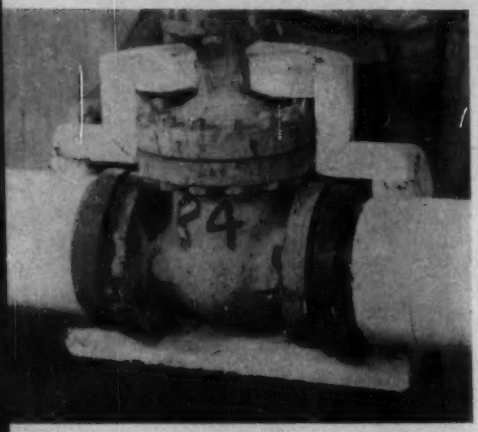


FIGURE 4—Prefab-insulation for valve slips on like a glove.

Asphalt of 180 degree M.P. is good for most work.

Hot insulation requires various types of cements, depending upon their temperature limits and surface characteristics.

Fittings are assembled into half sections for easy installation in the field.

Installation of prefabricated cellular glass insulation is much more simple than by old, conventional methods. On low temperature installations, the covering is simpy secured in place with stainless steel wire or bands and all joints of the outermost layer sealed with a vapor barrier cement. A non-setting sealer is used between the flange cover and the pipe covering to provide slip joints. Over the installed insulation a suitable weather barrier is applied.

Hot insulation is applied in a similar manner, with the exception that a vapor seal between the edges of insulation is not required. In neither low nor high temperature application of flanged covers is it necessary to fill the void between the cover and the fitting. Typical flanged valve installation is shown on Figure 4.

Extending the prefabrication method to tanks, vessels, etc., the insulation can be cut to fit the contour of the equipment before application. Sidewall lags or curved segments can be rapidly fabricated. Heads can be fabricated with segments, or in some cases, they can be cut in one piece.

In all instances, precision cut and tightly fitted insulation results in a better, more efficient installation than loosely fitted insulation covered with cement.

Prefabrication Savings. Savings are realized by prefabrication in a number of ways. Foremost is that machine effort is substituted for manual effort. Power equipment can cut insulation much more quickly and cheaply than manually operated tools. Fundamentally, the same amount of cutting will be required whether it is done in the shop or in the field. Power saws will cut insulation at least ten times faster than a man can cut with a hand saw.

Other than savings on labor, material fabricated by power equipment can be cut much more accurately than can be done by hand. Because of this increased accuracy, leveling coats of cement on vessels and fitting covers can be eliminated. Also, because of the accuracy, the parts making up a fitting can be cemented together into half sections. These half sections in their finished form are strong and rigid. Therefore, these fittings can be removed and re-installed when necessary.

Speed of construction is another factor. Most piping is erected and the straight pipe insulated before the flanges and flanged valves can be tested. With the prefabrication system, all the fittings can be ready for fast erection at completion of the pipe test. This is particularly true of low temperature insulation. When necessary, low temperature piping can go into operation before all fittings are installed. Although this practice causes additional labor cost for ice removal before fitting covers are installed, being able to operate in an emergency without waiting for the insulation to be completed, may be of considerable value.

Down time for maintenance can be cut to a minimum by prefabrication, both by the re-use of fitting covers and by having prefabricated fitting covers available for rapid re-insulation.

Arguments may be presented to indicate that it is not practical to set up a shop for construction installation. However, in the past few years, we have proved that this is not the case. Our unit cost records of an installation by a contractor in 1951, and another contractor in 1956, show considerable cost savings in the installed price of fittings. During this period labor cost increased 37 percent, but because of prefabrication, our fitting cost was much less, thus holding the total cost of the installation almost to 1951 prices. An example of unit prices, for representative fittings, is shown in Table 2.

TABLE 2—Low Temperature Insulation

Pipe Size	Insulation Thickness	Flanges Line		Valves Flanged		Valves—S&W Fittings—S&W	
		1951	1956	1951	1956	1951	1965
2"	1½	6.10	7.30	20.35	14.01	2.05	1.53
	3	14.56	10.93	55.82	23.44	11.96	2.65
	4½	20.22	19.27	77.72	33.03	17.06	4.88
6"	1½	9.00	11.30	35.39	28.24	8.39	6.66
	3	20.92	18.00	87.66	40.69	24.90	10.53
	4½	32.59	32.38	134.25	62.20	36.48	15.86
High Temperature Insulation							
2"	1	3.82	5.32	13.02	11.28	1.56	1.32
	1½	4.06	5.64	13.74	11.53	1.58	1.64
6"	1	10.69	8.65	36.35	17.30	2.28	4.11
	1½	11.19	8.87	38.27	17.86	4.70	6.22

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ACKNOWLEDGMENT

The author would like to acknowledge the investigative work, design and tabulation of dimensions, which was carried out by Mr. R. E. Estep and to Mr. J. S. Mooney and Mr. D. W. Hamilton who assisted him. All are members of the Engineering Department of the Department of Design and Construction, Union Carbide Chemicals Company.

About the Author

William C. Turner is a staff engineer in charge of thermal insulation, coatings and acoustics for Union Carbide Chemicals Co., South Charleston, W. Va. Turner received his B.S. degree in electrical engineering from Washington University College, then spent several years as an air condition engineer prior to joining Union Carbide Chemicals in 1940.

SPECIAL MAINTENANCE REPORT

Does Your Meter Need Proving?

Here's a method, developed by the Chinese Petroleum Corporation, that will test your positive displacement meters for accuracy and calibrate tank cars at the same time.

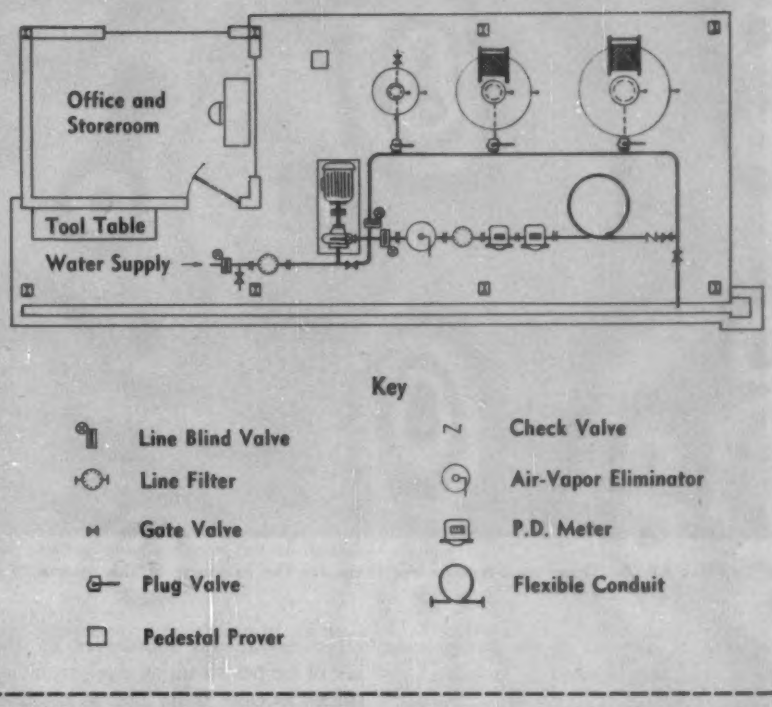

FIGURE 1—Centralized set-up provides a calibration service for tank cars and a proving station for P.D. meters.

Tzen-Yung Yang, Chinese Petroleum Corporation, Kaohsiung, Taiwan

REGARDLESS of its location, the positive displacement meter is expected to perform with a maximum accuracy in its operation. Or, it should be maintained well within its allowable measurement tolerance which has been established by local law or by mutual agreement between contracting parties.

In accordance with conventional proving methods, P.D. meters may be calibrated by volume, by weight, or by any other satisfactory method. Usually the volume method is suitable and preferable.

In bulk terminals, the proving tank and its auxiliary equipment is commonly erected near the meter installation. The liquid is passed through the meter under simulated operating conditions of temperature, pressure, rate of flow, etc. thence into the field prover tank where the volume is determined. Comparison of the two measurements indicates the accuracy of the meter being checked.

However, a field meter proving system has its inherent disadvantages if it is applied to a refinery where positive displacement meters are widely used. The reasons are:

- Cost of erecting an individual proving system for each separate meter installation is very expensive, although one proving system can be arranged to match a group of meters installed at the same site. However contamination is troublesome for stock return operations.
- Proving operations must be carried out in the field, therefore both labor and maintenance costs are comparatively high.

Engineers at Chinese Petroleum Corporation's Kaohsiung refinery were familiar with the calibration procedure for modifying tank cars. Since tank car calibration is also a volume measurement problem which consists of the same basic principles and fundamental equipment as P.D. meters require in their proving operation, an idea to build a centralized, volumetric, proving plant to cover both calibration service for tank cars and P.D. meters, was developed (Figure 1).

EQUIPMENT FEATURES

Prover Tanks. Three open type, prover tanks with a capacity of 1250-gallons, 500-gallons and 100-gallons, respectively, are erected in a bank (Figure 2). The largest prover tank can then meet the requirements of the large size P.D. meters operating at a maximum rated capacity of 1200 GPM.

Water Source. P.D. meters are generally proved using a liquid of similar physical characteristics to that which it normally measures. However, water is an ideal test liquid since it has a low vapor pressure, is stable, clear, immiscible with hydrocarbons, nonflammable and similar in viscosity to most light petroleum products. A water supply line of approximately 50 psi static pressure is connected to the proving pipe line

FIGURE 2—Three open-type prover tanks are the backbone of this system.

system at the end of the pump suction side and blocked by a valve.

Volume Variable Pump. In order to provide good meter performance, a volume adjustable pump shall be used to boost the testing liquid to the flow rate at which the meter is normally operated. We have installed a motor driven, centrifugal pump which develops a low head pressure but which has a large delivery with a rated capacity of 660 gpm. If it is boosted by water pressure, the discharge can approach 800 gpm. Volume adjustment is obtained by using a by-pass device installed ahead of the pump suction and after the discharge outlet.

Air-Vapor Eliminator. A shop made, 24-inch diameter, air-vapor eliminator is placed ahead of the meter installation. The bleeding line is not connected to the down-stream side of meter proving pipe. It is allowed to remain open to the atmosphere in order that no spillage will result in case the bleeding valve is damaged.

Strainers. Both pump and meter should be well protected against abrasion or injury from the intrusion of grit, scale, and foreign matter or other extraneous substances by the use of proper straining equipment installed as close to its inlet as possible. We used a conventional line filter with a 20 mesh screen for the boost pump, and a 40 mesh filter screen for the meter to be proved (40 mesh has long been recognized by many meter manufacturers as the minimum mesh recommended for P.D. meter straining equipment).

Master Meter. A spare meter (called a master meter) is calibrated against one of the three prover tanks at a definite flow rate until its accuracy is established. The master meter is used as a portable yardstick to measure inaccuracies of other meters by connecting it to the proving loops. The incorrect meter is checked in series with the master meter until its accuracy is determined. At the proving station, one or more meters of similar service conditions can be calibrated by one proving operation either in series with the master meter or against a prover tank.

Flexible Hose. A 4-inch inside diameter, light duty, rubber hose, with a minimum bending radius of two feet, has been used successfully with the proper pipe reducer as a flexible conduit to match the connection of any size meter to be proved.

Check Valve. A check valve is necessary to prevent test liquid drain-back which would create an improper reading on the prover tank neck. It should be placed at the down-stream end of the flexible hose. This is particularly significant for protection of the meter and its auxiliary equipment from shock pressure and water hammer when the liquid velocity exceeds 4 to 5 feet per second and a fast closing of discharge valve is used.

Plug Valve. An auto-lubricated plug valve is installed at the bottom inlet of each prover tank. The valve provides the advantage of quick operation, open to close. But the shock pressure and hammer should be carefully eliminated by a "soft closing" of the valve.

Line Blind Valve. It is very important to secure a positive, permanent shutoff at any unmetered path in the pipe line during the meter proving period. The use of a line blind valve or valve with a blanking device is considered good practice. However, the fire or accident hazard and loss of products caused by the spillage of line liquid becomes negligible since the test liquid is water.

Piping. The proving pipe line shall be smooth, uniform in size and level with a slight inclination upward to the prover tank, no air and vapor is then permitted to be trapped at dead spots in the pipe line. To prevent air from entering the drainage line, keep it full of liquid by maintaining the outlet drain level at a higher elevation than the body of drainage valve. Shown in photo (Figure 2, lower right) a gooseneck is installed at the end of the drainage line.

Thermometers. An error of 1 C. in measuring the temperature of the test liquid at 77 F. corresponds to an error of 0.026 percent of the volume metered. Correction of the temperature reading is a necessity. Each prover tank contains three dial thermometers with a range of 30-120 F. to record the internal temperature at three levels and are spaced 120 degrees apart. Also, a reliable thermom-

eter is installed at the inlet and outlet pipe of the proving line to measure the liquid temperature of metered stream.

PLANT FACILITIES

Tank Car Calibration. The modified tank car may be connected to the proving system by using a flexible hose. Through the proving boost pump, the car is either filled with definite quantities of water, measured by the prover tanks, or is emptied into the prover tanks. The operation is reversible and is easier to perform than the water gage plant method using elevated prover tanks.

P.D. Meter Proving. Any type of meter with a maximum rated capacity less than 1200 gpm or a normal delivery rate within 800 gpm can be satisfactorily proved either by prover tanks or by the master meter. In general, meter accuracies well within 0.1 percent can normally be attained by following a frequent proving program and making any necessary repairs.

Tank Truck Calibration. Deliver the filled compartments into the volumetric prover tank either through the truck unloading pump or by the station pump. The accuracy of the truck meter may also be checked during the same proving operation.

Other Services. If any smaller sized vessel requires an accurate volume calibration, it may be directly proved against a suitable prover tank. For instance, such smaller vessels as inhibitor, additive, odorant, dyeing and some chemical solution tanks installed in a process plant may be calibrated. Larger sized vessels of irregular form, such as multi-noded spheroid tanks, etc., may be indirectly proved through the use of a master meter whose accuracy has been already established at a definite flow rate.

Preventive Maintenance. All meters will tend to gradually over-deliver after continuous use, which is the result of normal wear because of dirt and foreign matter interfering with its operation. A definite maintenance schedule should be established to provide an adequate servicing of the meter equipment. This should include regular cleaning of the straining equipment, lubrication of all necessary parts, tightening the valve seats and counters.

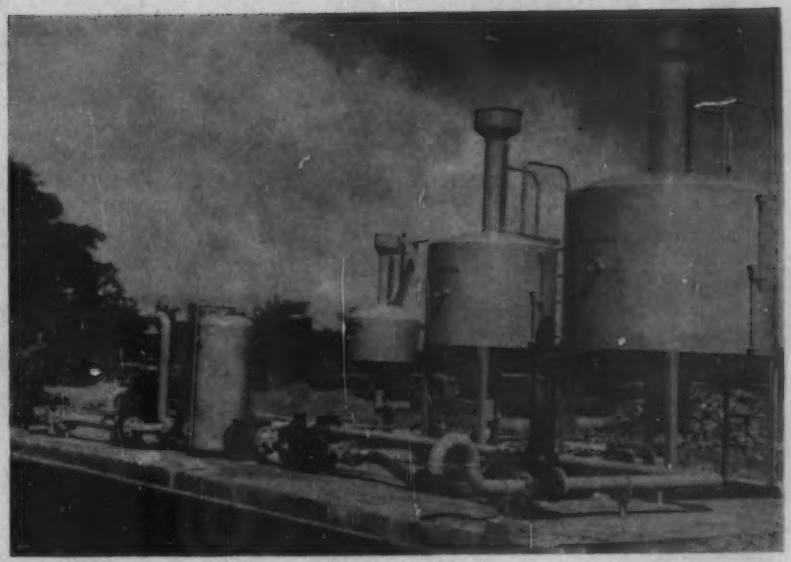

FIGURE 3—Gooseneck at end of drain line is higher than the drain valve. Thus, the proving line is always full of liquid.

The frequency with which a meter should be proved in general depends on the operating conditions, volume of throughput, continuity of service, fluid being metered, pressure, rate of flow, variation and accuracy requirement. Actual experience in the field has shown that minimum proving should be made at intervals of four months or once every 2 million gallons registered for a normally operated meter.

Recalibration of the meter should immediately follow cleaning, dismantling and repair. Before the proving test run, all internal rotating parts of the meter must be well lubricated with grease or suitable lubricant, which should be not easily washed out by water.

It should be noted that while meters, when new, are calibrated to a maximum tolerance of 0.1 percent over a range of flow from top-rated capacity to 20 percent of capacity, normal wear prior to recalibration may increase the variation to 0.2 percent.

Once the meter is accurately calibrated, water should be completely removed from the inside and the meter relubricated with light machine oil. If the meter is to be taken out of service for any length of time, it should be sealed with gas oil.

All maintenance data and proving result should be recorded on a meter maintenance card which is then available for reference purpose.

About the Author

Tzen-Yung Yang joined Chinese Petroleum Corporation following his graduation from Chao-Tung University of Shanghai in 1946 with a B.S. degree in chemical engineering. He helped build the harbor terminal and transmission pipe line at Port Kaohsiung, Taiwan, and has worked in the pumping house center and filing department of the Kaohsiung refinery. Since 1945 he has been in charge of oil storage and transportation facilities at the refinery.

ACKNOWLEDGMENT

The author expresses his appreciation to Chinese Petroleum Corporation for permission to publish this article, also to thank H. S. Yao, S. K. Peng and S. C. Chia for their directions in the preparation of this article.

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The Case of the

This case history shows that a carefully engineered chemical cleaning program will result in fewer maintenance problems for your reformers.

Joe D. Hudson
Oakite Products, Inc.
Dallas

WORK DONE over the past three years at an Ohio refinery has proved the practicality of chemically cleaning the plant's platinum catalyst reforming unit. The unit reforms naphthas at 33 octane into gaslone at 85 octane.

Components cleaned included the absorber and depropanizer towers, the furnace, and heat exchangers. Checks made at the cleaning compound manufacturers' laboratory showed that the soil could be removed from the towers by using a solvent-acidic detergent, and from the exchangers and furnace by using a combination of inhibited acidic detergents. The tests also indicated that sulphur was a major component of the soil, and that in removing it, a large amount of H_2S would be liberated. It was necessary, therefore, to provide piping and connections to dispose of the gas as it formed.

Cleaning was to be done by circulation, and by soaking where needed to wet-out the hard, carbonized soils. The first requirement was a tank where solutions could be mixed and held. An 800-gallon tank, equipped with steam heating coils, was mounted on wheels so it could easily be moved from section to section. Pumps used for circulating solution through the various components were air- or gasoline-driven. Both tank and pumps were of acid-proof construction.

The tank was fitted at the top with a 20-foot length of 3-inch line so any remaining traces of H_2S could be vented to the atmosphere.

Towers. The towers were first to be cleaned. The absorber, 40 feet high, contains 12 32-inch diameter perforated trays, each hole $\frac{1}{8}$ inch across. Scale had plugged about 50 percent of the perforations and reduced the others to less than $\frac{1}{16}$ of an inch in diameter. The walls of the tower were covered with a black, flaky scale and oil deposit as much as $\frac{1}{8}$ inch thick.

Solution was made up of the recommended concentration of cleaning compound, in 500 gallons of water, and was circulated through a 4-inch line entering the top of the tower, returning to the solution tank by a 4-inch drain at the bottom. Steam for heating was injected into the bottom of the tower through a 2-inch line, and temperature was brought up to 180 F. and held at that point for 24 hours. As circulation progressed, another 50 gallons of detergent were added to the solution. Solution strength at the end of the 24-hour circulation period was approximately 10 percent, indicating considerable reaction with the soil.

The tower was then flushed out for half an hour, using fire hydrant water under 150 psi pressure. A neutralizing alkaline solution was then circulated through the tower, flushed out, and dumped.

The tower was opened, inspected, and pronounced clean. The cleaning operation had taken 32 hours and cost about $750, compared with previous hand cleaning time of 5 days and cost of about $3000.

The solution used to clean the absorber tower had been returned to

Scaled-Up Reforming Unit

the tank, which was now moved to the depropanizer. This tower contains 20 trays and is 55 feet high. The trays, perforated like those in the absorber, are 42 inches in diameter. The soil was similar to that in the absorber, but somewhat harder and dryer.

Water and detergent was added to the solution in the tank until volume was up to 750 gallons and detergent concentration up to initial level. Solution was circulated through a 4-inch line at the top of the depropanizer and out through a 4-inch line at the bottom. Tower was heated by steam injected at the bottom, and temperature was held between 160 and 180 F. Solution was circulated at a rate of 250 gallons per minute for 4 hours, then permitted to soak in the bottom where soil was heavier. Solution was again circulated for 4 hours, flushed, neutralized with alkaline solution, and flushed out.

Results again were very good. Costs had again been reduced by better

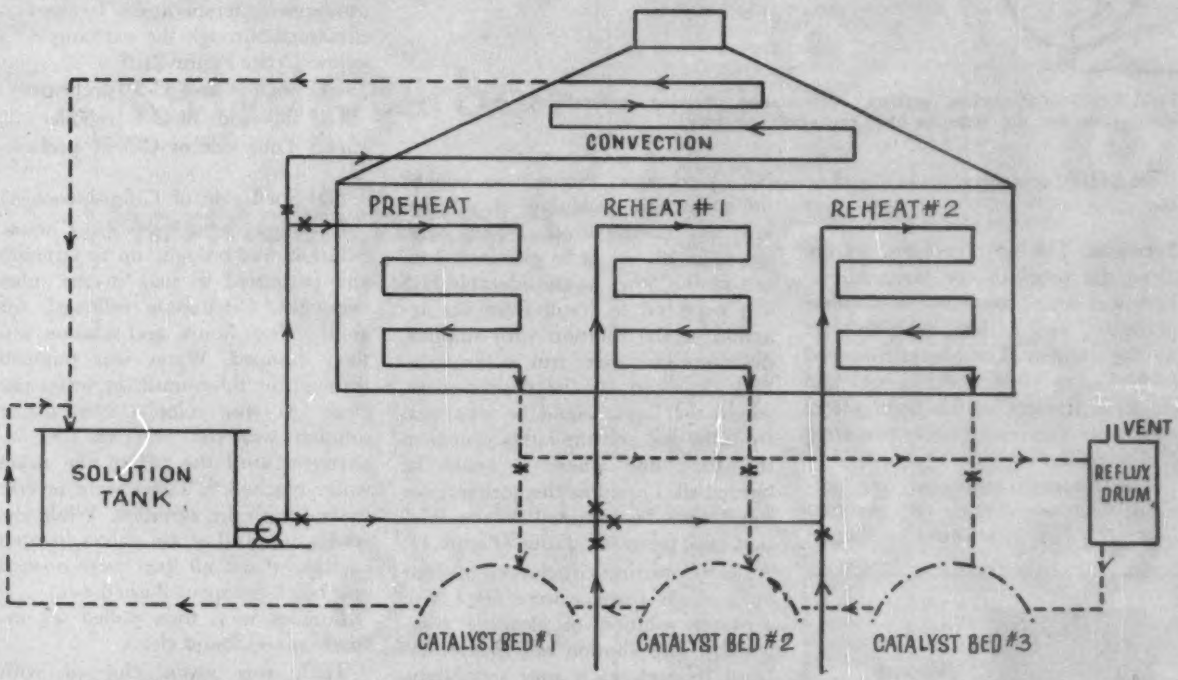

FIGURE 1—Piping is arranged so that the cleaning solution can be pumped to any section of this furnace.

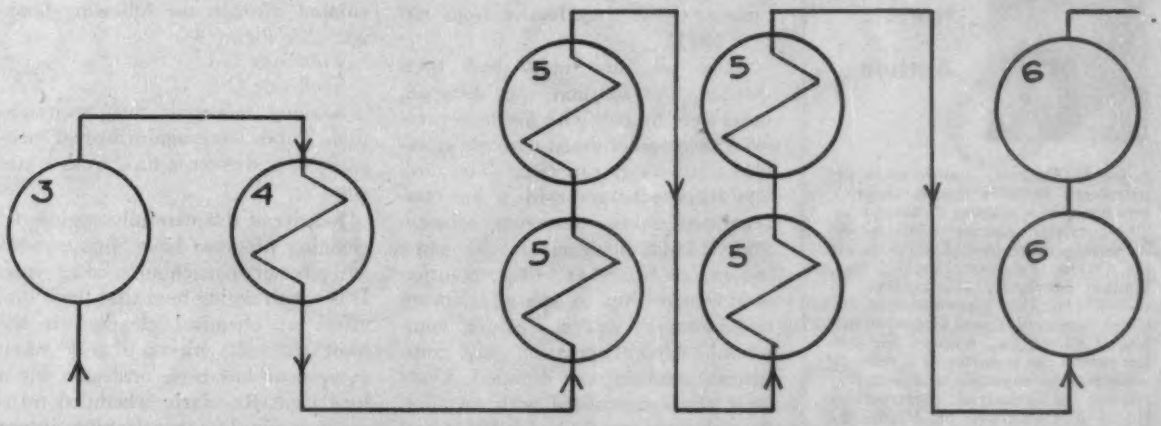

FIGURE 2—Heat exchangers are cleaned by circulating the solution through the shell side of some exchangers and the tube side of others.

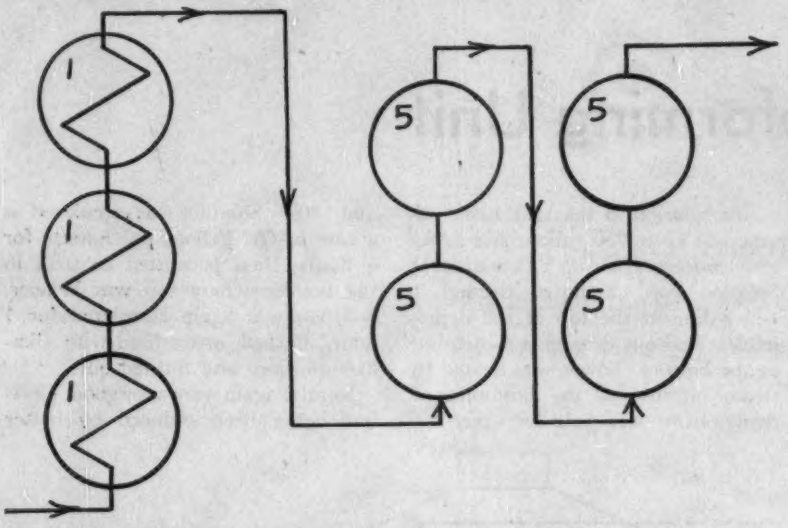

FIGURE 3—Circulation, soaking, recirculation, flushing, neutralizing and a final water rinse are the steps in heat exchanger cleaning.

than $1100, and time by better than two days.

Furnace. The next problem was to clean the tubes of the furnace. Soil here was scale, composed of sulphur, platinum, and carbon, with sulphur as the binder. The deposit ranged from 1/32 to 1/8 inch thick, and had cut heat transfer to the point where the unit was no longer operating economically.

The furnace consists of four sections: (A) convection; (B) preheating; (C) No. 1 reheater, and (D) No. 2 reheater. Piping was hooked up to permit pumping of solution into any of the units desired, with valves so placed as to give easy control of the flow. As considerable H_2S was expected to result from the reaction of the solution with sulphur, discharge lines were run to the accumulator drum on the depropanizer, where the liquid could be separated from the gas and the latter vented to the flare line where it could be burned off. Liquid in the accumulator could then be returned to the solution tank for recirculation (Figure 1).

Before starting circulation, all four units of the furnace were filled with a water solution of cleaning compounds. The solution was then circulated through each unit separately, for four hours, with temperature increasing 10 degrees hourly from 100 F to 140 F.

After all four units had been cleaned, the solution was dumped, units were flushed with fire hose pressure, then back flushed with air agitation until water ran clear. The tank was then recharged with a less concentrated acidic detergent solution and circulated again in the same manner as before at 140 F. Solution was brought up to strength during circulation by added cleaning compound. After circulation was completed, solution was dumped. Units were then neutralized with an alkaline solution, and flushed forward and back with air-agitated water until water ran clear. Cleaning of this section was completed in two days.

Heat Exchangers. The third phase of the cleaning operation was concerned with the heat exchangers, including the shell sides of some, tube sides of others. Here again the soil consisted mostly of sulphur compounds, carbon, and platinum in various mixtures. Tests showed it could be removed by reacting solution with the sulphur, breaking up the binder, and permitting removal of the oil by flushing. Tests again indicated that great amounts of H_2S would be liberated.

Used in this operation was a water solution of cleaning compound at atmospheric temperature. It was first circulated through the exchangers as follows: (See Figure 2).

(A) Shell side of C-3 (preheater)
(B) Tube side of C-4 (reboiler)
(C) Tube side of C-5 (4 preheaters)
(D) Shell side of C-6 (2 coolers)

Circulation continued for 4 hours. Solution was brought up to strength and permitted to soak in the tubes overnight. Circulation followed, for another four hours, and solution was then dumped. Water was pumped through the tubes until the water ran clear. At this point a neutralizing solution was run through the exchangers until the pH of the drain water reached 9. Tubes were reverse flushed with air agitation. While the system was full, drain valves in each exchanger and all lines were opened and black sediment flushed out.

Bundles were then pulled for inspection and found clean.

Tank was again charged with cleaning compound solution and circulated through the following hookup: (See Figure 3).

Tube side C-1
Shell side C-5

Soaking followed, then recirculation. Tubes were again flushed, neutralized, and given a final fresh water rinse.

Results of this carefully engineered cleaning program have been consistently better in each succeeding year. It is worth noting here that the initial effort at chemical cleaning is the most difficult, particularly when equipment has been onstream for a long time. Regularly scheduled turnarounds simplify the cleaning, insure fewer maintenance problems. ##

About the Author

Joe D. Hudson, consultant to the petroleum industry on its cleaning problems, is a veteran of more than 200 catalytic cracker turnarounds. A petroleum division field manager for Oakite Products, Inc., Dallas, Hudson previously was assistant to the mechanical superintendent at Cities Service Refining Corporation's Lake Charles, La., refinery. He also has served the industry as a refinery construction engineer and superintendent of industrial construction. He is a University of Mississippi graduate.

Applied Hydrocarbon Thermodynamics

Part 1
A review of fundamentals

About the Author

Wayne C. Edmister was born in Cleveland, Okla., and earned his B.S. in mechanical engineering from Oklahoma Agricultural and Mechanical College in 1932. He then attended Cornell University as a Telluride Association fellow and received his M.M.E. in 1934. In 1942 Oklahoma A and M College awarded him a Chem. E. professional degree.

From 1933-1934, Edmister worked as a research engineer for Sinclair Prairie Oil and Gas Company in the Oklahoma oil fields. He then joined the Standard Oil Company (Indiana) as a research and design chemical engineer. After nine years at the Whiting Research Laboratory, Edmister went to Washington where he coordinated synthetic rubber plant utilities for the Rubber Reserve program of the Reconstruction Finance Corporation. In 1944, Edmister joined the Foster Wheeler Corporation in New York as a senior process engineer on petroleum refinery projects. From there, in 1947, he went to Hydrocarbon Research, Inc., in New York where he was assistant director of process development, working on nuclear reactor design and the gasification of coal.

In 1948 he became a member of the faculty of Carnegie Institute of Technology, where he was a professor of chemical engineering. In 1952 he joined the staff of California Research Corporation at Richmond, California, where he is now an Engineering Associate, leading a group working on technical data compilation and the development of unit operations and design methods.

Edmister has been an instructor or guest lecturer for Illinois Institute of Technology, 1938-1942; New York University, 1947-1948; and the University of California, 1953 to date. He has done consulting work for General Chemical Division of Allied Chemical and Dye Corporation, Bureau of Mines Office of Synthetic Liquid Fuels, The Lummus Company, Office of Rubber Reserve, L'Air Liquide, and Vulcan Engineering Division.

Edmister is a member of the American Institute of Chemical Engineers, the American Society of Mechanical Engineers, the American Chemical Society, Pi Tau Sigma, Sigma Tau, Phi Kappa Phi, and Sigma Xi. He has taken part in a number of AIChE activities, particularly as chairman and editor of symposia, moderator of discussions, and member of committees.

Edmister has authored numerous technical papers. His scientific contributions have been in the fields of thermodynamic properties of fluids, multicomponent fractionation, hydrocarbon and petroleum processing, coal gasification, and chemical plant process design.

At the annual meeting of ASME in New York December 1-6, 1957, Edmister received the Richards Memorial Award given each year "for outstanding achievement in mechanical engineering within 20 to 25 years after graduation."

Wayne C. Edmister
California Research Corporation
Richmond, California

THERMODYNAMIC TOOLS for solving processing engineering problems are the objectives of this series of articles. Sufficient theory and mathematical derivations will be included to show the basis for and preparation of these tools.

No attempt is made to make this a comprehensive treatise of thermodynamics. For a discussion of fundamental laws, proofs of theorems, and rigorous development of equations, the reader is referred to the many fine

Applied Hydrocarbon Thermodynamics . . .

CERTAINLY no other series of articles in any technical magazine has enjoyed the wide acceptance and the extreme popularity as that received by Wayne Edmister's series in the PETROLEUM REFINER on "Application of Thermodynamics to Hydrocarbon Processing." This series appeared from July 1947 until December 1949. Our readers ordered literally thousands of the reprints of this series and it proved to be the best seller of any series in our history.

We have been promising you additional similar articles by Wayne Edmister. We are especially pleased to have this new series starting in this issue.

Following are tentative chapter titles for the first 12 monthly installments:

1. **Fundamentals Resume**
2. **Pressure-Volume-Temperature Data Review**
3. **Liquid and Vapor Densities**
4. **Compressibility Factor and Equation of State Correlations**
5. **Thermal Expansion Factors for Petroleum**
6. **Improved Mollier Charts for Hydrocarbons**
7. **Isentropic Exponents for Gases**
8. **Generalized Isentropic Exponents From Entropy Balances**
9. **Adiabatic Compression and Expansion Calculations**
10. **Equilibrium Flash Vaporization of Light Oils at Atmospheric and Higher Pressures**
11. **Vacuum Flash Correlations For Heavy Oils**
12. **Illustrative Examples**

You have indicated by your many letters how much the past series has helped you, and therefore we know you will also welcome the present work. Because we ran out of reprints of the earlier series, we are doing two things for you:

1. We asked Wayne Edmister to prepare the fundamentals resume and review articles as the starters for this new series in case you are a little rusty with your basic thermodynamics.

2. We arranged with Wayne Edmister to update a lot of the data from the earlier series so that you can have a complete new set even though you are not able to obtain a reprint of the previous series.

Topics to be covered by future chapters include:

1. **Integral Technique for Petroleum Distillation Calculations**
2. **Improved Generalized Thermodynamic Properties Correlations**
3. **Activity Coefficients and "K" Values**
4. **Partial Enthalpies of Hydrocarbons**
5. **Heat Contents of Petroleum Fractions**
6. **Heats of Reaction and Chemical Equilibria**

text books that are available. For convenience, many of these texts are listed at the end of this chapter.

This discussion of fundamentals is restricted to simple but real systems. The thermodynamics for systems with more than one phase present or with chemical reactions taking place have not been covered.

Heats of vaporization, fusion, and solution will be covered later. So will fugacities and activity coefficients and the reaction equilibrium constants. This and other additional theory and equations will be developed as they are needed.

For the present purposes, compactness in presenting thermodynamics fundamentals is more important than thoroughness.

Scope. Thermodynamics has been defined as "Science of Heat and Work."

Thermodynamics can *predict*: (a) Behavior of substances with minimum experimental data; and (b) performance limitations of processes, e.g., possible extent and maximum work, thus providing efficiency standards.

An *advantage* of thermodynamics is that conclusions reached by it are independent of molecular or kinetic hypothesis.

Limitations of thermodynamics are: (a) It cannot predict rates or actual performance (only standards of perfection); and (b) it applies only to a large number of molecules (not to individual molecules).

Definitions. A thermodynamic *system* is the portion of universe arbitrarily chosen for study, while *surroundings* refer to portion of universe excluded from system.

Thermodynamic *properties* are the variables necessary to fix the state of a substance. Properties are functions of the state and in no way dependent on its history. As will be shown later, heat and work are not functions of the state and, therefore, are not properties.

It follows that a change in a property is dependent only on the initial and final states and in no way dependent upon the method or path followed in going from one state to another.

Intensive properties are not dependent upon the mass of the substance, as illustrated by: temperature, pressure, fugacity, etc.

Extensive properties are dependent upon the mass of the substance, as illustrated by: volume, enthalpy, entropy, etc.

Temperature is the potential or driving force for flow of heat. It is an intensive variable or parameter of the

system. *Thermometry* is the measurement of temperature by changes in gas volume or e.m.f.

Pressure is a force per unit area. *Vapor pressure* is an equilibrium property of a substance. *System pressure* is a defining parameter or an intensive variable of a system.

Any change (reaction, vaporization, condensation, expansion, compression, etc.) of a system is a thermodynamic *process.*

A process may take place under conditions defined as:

Adiabatic:	no heat added to or removed from system
Isothermal:	constant temperature
Isometric:	constant volume
Isobaric:	constant pressure
Isentropic:	constant entropy
Isenthalpic:	constant enthalpy

Experiments have shown that changes in a system eventually stop; and unless conditions are altered, no further change will take place. An *equilibrium* state then exists.

Phase Rule. When the *state* or *phase* condition of a system is defined by fixing the required number of properties, all other properties are fixed. The *Phase Rule* gives the number of independent variables, or degrees of freedom for a system, as follows:

$$F + \phi = N + 2 \qquad (1.1)$$

where F = number of degrees of freedom or independent variables
N = number of components
ϕ = number of phases

The independent variables referred to in Equation 1.1 include pressure, temperature, and mole fractions of components.

Reversibility. A *reversible* process is a series of equilibrium states with the criteria:

1. Allow process to go forward along selected path and measure forward work.†
2. Return process along same path and measure backward work.†
3. If sum of forward and backward work† equals zero, the process is reversible.

Heat and Work. By definition:

Q = heat added to system
W = work done by system

Heat, Q, is the agent postulated to account for temperature differences. In other words: Heat is the type of energy which responds to temperature only as a potential. Heat is energy in motion, and unit of heat is amount necessary to effect a standard temperature change in a standard substance at a standard condition. Heat is measured by a calorimeter.

Work, W, is also energy in transit. Work includes all forms of energy which are completely interconvertible to heat (by friction) but not vice versa. Experiments show that heat and work accompanying a process depends on details of process and cannot be determined by end points alone. Work is defined as force times distance in direction of force.

Reversible Work equation is found by expressing Work (= force times distance) differentially:

$$d^*W = Fdx = PA\frac{dV}{A} = Pdv, \qquad (1.2)$$

from which $W = \int PdV$ for a reversible process.

If the process is not reversible, the actual work will be numerically greater than $\int PdV$ for compression and less than $\int PdV$ for expansion. If expanding piston works against a force that is significantly less than the P·A product, the work will be less than $\int PdV$. This term, $\int PdV$, is the *batch* or *total work* for a nonflow process.

Shaft work is the energy available to turn the shaft of an expansion engine or a turbine. For actual processes it is less than reversible work because of friction.

The shaft work for a reversible *batch* or *nonflow process* is equal to $\int PdV$. For a *flow process,* an amount of energy equal to $\Delta(PV)$ is required to keep the fluid flowing through the system when changes in kinetic and potential energies are negligible. The shaft work for a reversible flow process is $-\int VdP$. A relationship between *batch, shaft,* and *flow* works for complete reversibility is obtained by differentiating the PV product, as follows:

$$d(PV) = PdV + VdP \qquad (1.3)$$

Integrating

$$P_2V_2 - P_1V_1 = \int_1^2 PdV + \int_1^2 VdP \qquad (1.4)$$

From Equation 1.4

$$-\int_1^2 VdP = \int_1^2 PdV - \Delta(PV) \qquad (1.5)$$

For reversible process

$-\int_1^2 VdP$ = shaft work

$\int_1^2 PdV$ = batch work

$\Delta(PV)$ = flow work

$$\boxed{W_s = W - \Delta(PV)} \qquad (1.6)$$

(As mentioned above, work terms refer to work done by fluid system.)

First and Second Laws

The *first law* of thermodynamics is a *conversation* of *energy* statement

$$E_2 - E_1 = \Delta E = Q - W \qquad (1.7)$$

where: $E_2 - E_1$ = the change in energy of the system
Q and W are as defined above

In differential form

$$dE = d^*Q - d^*W \qquad (1.8)$$

Equation 1.7 is the preferred form of the mathematical definition of the first law. Equation 1.8 is included for

† Refers to all work terms.

‡ Where: d^*Q and d^*W are inexact differentials and depend upon the path followed.

convenience in deriving thermodynamic functions.

The *second law* of thermodynamics deals with *energy* degradation and introduces an abstract quantity called entropy, S, which is defined for a reversible process by the following

$$d^*Q = TdS \tag{1.9}$$

Combining Equations 1.2, 1.8, and 1.9 gives the following important relationship:

$$\boxed{dE = TdS - PdV} \tag{1.10}$$

Equation 1.10 will serve as the basis for developing equations for other thermodynamic functions.

Other Functions. By definition the *enthalpy* is

$$H = E + PV \tag{1.11}$$

Differentiating

$$dH = dE + PdV + VdP \tag{1.12}$$

Combining Equations 1.10 and 1.12

$$\boxed{dH = TdS + VdP} \tag{1.13}$$

Another term, *net work,* is defined as

$$A = E - TS \tag{1.14}$$

Differentiating

$$dA = dE - TdS - SdT \tag{1.15}$$

Combining Equations 1.10 and 1.15

$$\boxed{dA = -SdT - PdV} \tag{1.16}$$

Free energy is defined as

$$F = H - TS \tag{1.17}$$

Differentiating

$$dF = dH - TdS - SdT \tag{1.18}$$

Combining Equations 1.13 and 1.18

$$\boxed{dF = -SdT + VdP} \tag{1.19}$$

Equations 1.10, 1.13, 1.16, and 1.19 are the basic differential equations for the four thermodynamic potentials *energy, enthalpy, net work,* and *free energy.* For more convenient application, they will be converted to other independent variables. This requies the Maxwell Relations for transformation of variables.

Maxwell Relations. The *Maxwell Relations* relate pressure, volume, temperature, and entropy. This makes them most useful in deriving thermodynamic formulations.

There are four Maxwell Relations, each obtained from one of the above four basic differential equations; i.e., 1.10, 1.13, 1.16, and 1.19, by using Green's Theorem. If

$$dZ = MdX + NdY \tag{1.20}$$

it can be shown that

$$\left(\frac{\partial N}{\partial X}\right)_Y = \left(\frac{\partial M}{\partial Y}\right)_X \tag{1.21}$$

Equation 1.21 is obtained by defining Z as a function of X and Y which leads to the following total differential which is Equation 1.20.

$$dZ = \left(\frac{\partial Z}{\partial X}\right)_Y dX + \left(\frac{\partial Z}{\partial Y}\right)_X dY$$

$$\text{let } M = \left(\frac{\partial Z}{\partial X}\right)_Y \text{ and } N = \left(\frac{\partial Z}{\partial Y}\right)_X$$

This is the same as Equation 1.20. Since the order of differentiation is unimportant with two or more variables, the first derivative of M with respect to Y is equal to the first derivative of N with respect to X, i.e.,

$$\frac{\partial^2 Z}{\partial X\,\partial Y} = \left(\frac{\partial M}{\partial Y}\right)_X = \left(\frac{\partial N}{\partial X}\right)_Y$$

This is the Green's theorem relationship given by Equation 1.21.

Using this Green's theorem relationship, the four Maxwell Relations are written by inspection from the reference equations, as follows:

From Equation 1.10

$$\boxed{\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V} \tag{1.22}$$

From Equation 1.13

$$\boxed{\left(\frac{\partial T}{\partial P}\right)_S = \left(\frac{\partial V}{\partial S}\right)_P} \tag{1.23}$$

From Equation 1.16

$$\boxed{\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V} \tag{1.24}$$

From Equation 1.19

$$\boxed{\left(\frac{\partial S}{\partial P}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_P} \tag{1.25}$$

These four Maxwell relations are used with the four basic equations to obtain convenient formulations.

Expressions for the isothermal effect of volume on energy and of pressure on enthalpy are the most frequently used.

Dividing Equation 1.10 by dV, keeping T constant, and combining with Equation 1.24 gives the isothermal effect of volume on energy.

$$\boxed{\left(\frac{\partial E}{\partial V}\right)_T = \left[T\left(\frac{\partial P}{\partial T}\right)_V - P\right]} \tag{1.26}$$

Dividing Equation 1.13 by dP, keeping T constant, and combining with Equation 1.25 gives the isothermal effect of pressure on enthalpy.

$$\boxed{\left(\frac{\partial H}{\partial P}\right)_T = \left[V - T\left(\frac{\partial V}{\partial T}\right)_P\right]} \tag{1.27}$$

Equations 1.26 and 1.27 will be used in formulations that follow.

Heat Capacities. The heat capacity at constant pressure is defined as

$$C_P = \left(\frac{\partial H}{\partial T}\right)_P = \left(\frac{\partial Q}{\partial T}\right)_P \qquad (1.28)$$

At constant pressure

$$dQ = TdS = dH = C_p\,dT \qquad (1.29)$$

Rearranging

$$\left(\frac{\partial S}{\partial T}\right)_P = \frac{C_p}{T} = \frac{1}{T}\left(\frac{\partial H}{\partial T}\right)_P \qquad (1.30)$$

Differentiating with respect to pressure

$$\left(\frac{\partial^2 S}{\partial T\,\partial P}\right) = \frac{1}{T}\left(\frac{\partial C_p}{\partial P}\right)_T = \frac{1}{T}\left(\frac{\partial^2 H}{\partial T\,\partial P}\right) \qquad (1.31)$$

Differentiating Equation 1.25 with respect to T, keeping P constant

$$\left(\frac{\partial^2 V}{\partial T^2}\right)_P = -\left(\frac{\partial^2 S}{\partial P\,\partial T}\right) \qquad (1.32)$$

Combining Equations 1.31 and 1.32

$$\boxed{\left(\frac{\partial C_p}{\partial P}\right)_T = -T\left(\frac{\partial^2 V}{\partial T^2}\right)_P} \qquad (1.33)$$

The heat capacity at constant volume is defined as

$$C_V = \left(\frac{\partial E}{\partial T}\right)_V = \left(\frac{\partial Q}{\partial T}\right)_V \qquad (1.34)$$

At constant volume

$$dQ = TdS = dE = C_V\,dT \qquad (1.35)$$

Rearranging

$$\left(\frac{\partial S}{\partial T}\right)_V = \frac{C_V}{T} = \frac{1}{T}\left(\frac{\partial E}{\partial T}\right)_V \qquad (1.36)$$

Differentiating with respect to volume

$$\left(\frac{\partial^2 S}{\partial T\,\partial V}\right) = \frac{1}{T}\left(\frac{\partial C_V}{\partial V}\right)_T = \frac{1}{T}\left(\frac{\partial^2 E}{\partial T\,\partial V}\right) \qquad (1.37)$$

Differentiating Equation 1.24 with respect to T, keeping V constant

$$\left(\frac{\partial^2 P}{\partial T^2}\right) = \left(\frac{\partial^2 S}{\partial V\,\partial T}\right) \qquad (1.38)$$

Combining Equations 1.37 and 1.38

$$\boxed{\left(\frac{\partial C_V}{\partial V}\right)_T = T\left(\frac{\partial^2 P}{\partial T^2}\right)_V} \qquad (1.39)$$

Heat Capacity Differences. The development of an expression for C_P—C_V is started by differentiating Equation 1.11 with respect to T, keeping V constant

$$\left(\frac{\partial H}{\partial T}\right)_V = \left(\frac{\partial E}{\partial T}\right)_V + V\left(\frac{\partial P}{\partial T}\right)_V \qquad (1.40)$$

Next, H is expressed as a function of P and T in differential form

$$dH = \left(\frac{\partial H}{\partial T}\right)_P dT + \left(\frac{\partial H}{\partial P}\right)_T dP \qquad (1.41)$$

Divide Equation 1.41 by dT, keeping V constant

$$\left(\frac{\partial H}{\partial T}\right)_V = \left(\frac{\partial H}{\partial T}\right)_P + \left(\frac{\partial H}{\partial P}\right)_T \left(\frac{\partial P}{\partial T}\right)_V \qquad (1.42)$$

Combining Equations 1.40 and 1.42 with the definitions of C_P and C_V (Equations 1.28 and 1.34) and Equation 1.27 and rearranging

$$\boxed{C_P - C_V = T\left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial P}{\partial T}\right)_V} \qquad (1.43)$$

Equation 1.43 can be put in another form by a transformation of variables. Defining V as function of T and P

$$dV = \left(\frac{\partial V}{\partial T}\right)_P dT + \left(\frac{\partial V}{\partial P}\right) dP \qquad (1.44)$$

Divide by dT, keeping V constant and rearranging

$$\left(\frac{\partial P}{\partial T}\right)_V = -\frac{\left(\frac{\partial V}{\partial T}\right)_P}{\left(\frac{\partial V}{\partial P}\right)_T} \qquad (1.45)$$

Combining Equations 1.43 and 1.45

$$\boxed{C_P - C_V = -T\frac{\left(\frac{\partial V}{\partial T}\right)_P^2}{\left(\frac{\partial V}{\partial P}\right)_T}} \qquad (1.46)$$

Energy. Defining energy as a function of T and V and writing the total differential

$$dE = \left(\frac{\partial E}{\partial T}\right)_V dT + \left(\frac{\partial E}{\partial V}\right)_T dV \qquad (1.47)$$

Combining Equations 1.26, 1.34, and 1.47 gives the following expression for the effects of temperatures and volume on the energy

$$\boxed{dE = C_V\,dT + \left[T\left(\frac{\partial P}{\partial T}\right)_V - P\right]dV} \qquad (1.48)$$

Enthalpy. A similar equation is derived for enthalpy by defining H as a function of T and P and writing the total differential

$$dH = \left(\frac{\partial H}{\partial T}\right)_P dT + \left(\frac{\partial H}{\partial P}\right)_T dP \qquad (1.49)$$

Combining Equations 1.27, 1.28, and 1.49 gives the following expression for the effects of temperature and pressure on the entalpy

$$\boxed{dH = C_p dT + \left[V - T\left(\frac{\partial V}{\partial T}\right)_P\right]dP} \qquad (1.50)$$

Entropy. Defining entropy as a function of T and V

$$dS = \left(\frac{\partial S}{\partial T}\right)_V dT + \left(\frac{\partial S}{\partial V}\right)_T dV \qquad (1.51)$$

Combining Equations 1.24, 1.35, and 1.51 gives

$$\boxed{dS = \frac{C_v}{T}dT + \left(\frac{\partial P}{\partial T}\right)_V dV} \qquad (1.52)$$

An expression for entropy as a function of T and P is derived similarly

$$dS = \left(\frac{\partial S}{\partial T}\right)_P dT + \left(\frac{\partial S}{\partial P}\right)_T dP \qquad (1.53)$$

Combining Equations 1.25, 1.29, and 1.53 gives

$$\boxed{dS = \frac{C_p}{T}\ dT - \left(\frac{\partial V}{\partial T}\right)_P dP} \qquad (1.54)$$

Joule-Thomson Coefficient. By definition, the Joule-Thomson coefficient is

$$\mu = \left(\frac{\partial T}{\partial P}\right)_H \qquad (1.55)$$

An expression for μ may be obtained by expressing H as a function of T and P, i.e., Equation 1.41; dividing this expression by dP, keeping H constant and rearranging gives:

$$\left(\frac{\partial T}{\partial P}\right)_H = -\frac{\left(\frac{\partial H}{\partial P}\right)}{\left(\frac{\partial H}{\partial T}\right)_P} \qquad (1.56)$$

Combining Equations 1.27, 1.28, and 1.56 gives:

$$\boxed{\mu = \left[\frac{T\left(\frac{\partial V}{\partial T}\right)_P - V}{C_P}\right]} \qquad (1.57)$$

The above equations are basic and apply to single and multi-component systems. Generally their application is limited to single phase systems with no change in chemical form. Changes in phase and chemical form will be taken up later.

NOMENCLATURE AND SYMBOLS

Symbols used in equations and charts and in the descriptive material follow the A.I.Ch.E. notation as closely as possible.

Because there is an insufficient number of letters in the two alphabets (English and Greek) usually used for symbols in technical notation, considerable duplication of symbols is inevitable. In order to avoid misunderstanding, symbols will be defined with the technical material concerned.

One deviation from the A.I.Ch.E. symbols is the symbol for pressure. The following will be used:

P = total or system pressure (pounds per square inch absolute), psia.

$\bar{P}_i$ = partial pressure of $_i$th component in same units.

P_i° = vapor pressure of $_i$th component in same units.

Additional pertinent material from the publications of API Project 44 follows:

Circular superscript, °, denotes the thermodynamic standard reference state; i.e., the ideal gas state of unit fugacity, which is zero pressure for the enthalpy.

Numerical subscripts identify the temperature condition for thermodynamic properties; for example, $T_{25.16}$ or T_1 denote the absolute temperature in degrees Kelvin.

In general, capital letters will be used to designate molar thermodynamic properties, such as: V = cu ft/lb mole, H = Btu/lb mole, etc., and lower case letters will be used to designate specific thermodynamic properties, such as: v = cu ft/lb, h = Btu/lb, etc.

$(H^\circ - H_o^\circ)$ = the heat content of enthalpy in the standard state at the temperature T less the enthalpy in the standard state at O° K.

S° = the entropy of the given substance in the standard state at the indicated temperature, omitting nuclear contributions, isotopic mixing, nuclear spins, etc., which contributions cancel out in all reactions of practical importance.

Δ denotes the increment of a given property for a given process or reaction, taken as the value for the final state (sum or products) less that for the initial state (sum of reactants).

ΔH, ΔF, ΔS, ΔC_P = the increment in enthalpy, free energy, entropy, and heat capacity, respectively, for the given process or reaction, with each substance in a specified thermodynamic state.

A partial list of additional notations which are used in thermodynamics are:

T_r, P_r, V_r, etc. = reduced temperature, pressure, and volume, respectively, which are obtained by dividing the absolute temperature, pressure, or volume by the corresponding critical property.

T_c, P_c, V_c, etc. = critical value.

T_{pc}, P_{pc}, V_{pc}, etc. = pseudo-critical value.

T_{pr}, P_{pr}, V_{pr}, etc. = pseudo-reduced property which is obtained by dividing the absolute temperature, pressure, or volume by the corresponding pseudo-critical property.

T_i, P_i, V_i, etc. = temperature, pressure, volume of component i in a mixture.

$\left(\frac{\partial V}{\partial T}\right)_{P,\,N}$ = partial derivative of V with respect to T at a constant pressure, P, and a constant number of moles, N.

$\bar{V}_i = \left(\frac{\partial V}{\partial N}\right)_{P,\,T,\,N_j\ldots}$ The bar over V_i indicates it is a partial volume of component i and is equal to the partial derivative of the whole volume with respect to the quantity of component i, while pressure, P, temperature, T, and the quantity of the other components, $N_j\ldots$, are held constant.

Compositions will be designated as:

x_i = mole fraction of $_i$th component and w_i = weight fraction of $_i$th component.

$\bar{H}$, $\bar{S}$, $\bar{C}_p$, etc. = partial enthalpy, entropy, heat capacity. In a multicomponent mixture the total enthalpy, entropy, or heat capacity is equal to $H = \Sigma x_i H_i$, $C_p = \Sigma x_i C_{pi}$ where H = enthalpy in Btu/lb mole of mixture, etc., $\Sigma x_i \bar{H}_i + x_2\bar{H}_2 + \ldots$ etc., and x_i is the mole fraction of components.

A misleading notation found in the literature is d_{15}^{15}, which at first glance appears to be density. Actually, it is the specific gravity as it is the density of the substance at 15 C. divided by the density of water at 15 C. and is dimensionless.

d^*=inexact differential operator.

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TO BE CONTINUED

Petrochemicals to Keep Pace in '58

Using past data and current production capacities, trends are developed which permit projections for this year.

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TO GAIN PERSPECTIVE on the rapidly developing petrochemical industry, we must periodically review the recent past. New product development and market growth can be observed and utilized in projecting estimates of future expansion. This year's review of the petrochemical situation, therefore, includes a look at the growth in annual production of the major petrochemicals since 1953.

Prices Starting to Rise. Data on the 1957 market shows major adjustments forced by continued increase in costs. Rising expenses of production and distribution have beset the industry during recent years, yet increased efficiency has permitted holding of price indices to levels lower than those of other commodities. In many areas, this retention of price levels has been achieved only at appreciable reductions in profits. Increased capacity in many parts of the petrochemical industry has exceeded immediate market demands, and the resulting competitive sales situation has also contributed to holding prices down.

The increasing pressure of rising costs, however, has forced many prices upward in 1957. In some instances, this price rise has taken place despite a surplus of productive capacity. Nobody wants to operate at a loss—a sentiment which can be well understood.

Table 1 shows published prices for major petrochemicals toward the end of 1957, as compared with 1956. For the first time in several years, the number of major petrochemicals which have increased in price exceeds the number which have remained stable or have decreased. Nevertheless, some of the more stable commodities have held at a fixed price level for three to four years, as indicated.

Production Data and Estimates. As before, the annual report of the U. S. Tariff Commission on Synthetic Organic Chemicals has been the major source of production data. Other references, as indicated, have supplied the balance of the 1956 production data. Estimates were made of 1957 production before year-end data were available. Predictions of 1958 production are made at a time of a general slowdown in business; the optimistic figures are based on the premise that the petrochemical products and their end-products will continue to grow in volume even if total production decreases, as other more costly natural products or other synthetic sources are gradually displaced.

Table 2 summarizes the petrochemical production data from 1953 through the 1958 estimates. These same data are grouped and plotted in Figures 1 through 4, to show specific and general trends. The fast-growers may be distinguished immediately—ethylene, polyethylene, urea, glycerol, acrylonitrile, vinyl chloride and vinyl acetate leading the parade, with acetylene, ammonia and ethylene oxide following. Far down the line, with a slowly rising output are the early petrochemicals, acetaldehyde, acetone, acetic anhydride and acetic acid. It would be well, however, to examine each major petrochemical individually to determine some of the whys and wherefores of

TABLE 1—Comparative Prices for Some Major Petrochemicals
(Cents per pound, except when noted)

	3rd Quarter, 1956	3rd Quarter, 1957
Stable		
Acetic Acid	10	10
Acetic Anhydride	14	14*
Acrylonitrile	28	28
Benzene (per gallon)	36	36
Ethanol (per gallon)	47	47
Ethylene Oxide	15½	15½*
Ethylene Glycol	13½	13½
Xylene (per gallon)	34	34† ‡
Increases		
Acetaldehyde	9½	10
Acetone	8	8½
Ammonia	3¾	4½
Butadiene	15	15½
Butanol (secondary)	11½	12½
Carbon Tetrachloride	10	10¾
Methanol (per gallon)	30	32½
Phenol	18	18½
Vinyl Acetate	16½	17½
Vinyl Chloride	10½	11
Decreases		
Iso-Propanol (per gallon)	44	41
Styrene	16	12½
Toluene (per gallon)	34	31‡

* Stable 3 years.
† Stable for 4 years.
‡ Petrochemical Products—Coal-tar Xylene 32¢ Coal-tar Toluene 29½¢.

Petrochemicals to Keep Pace in '58 . . .

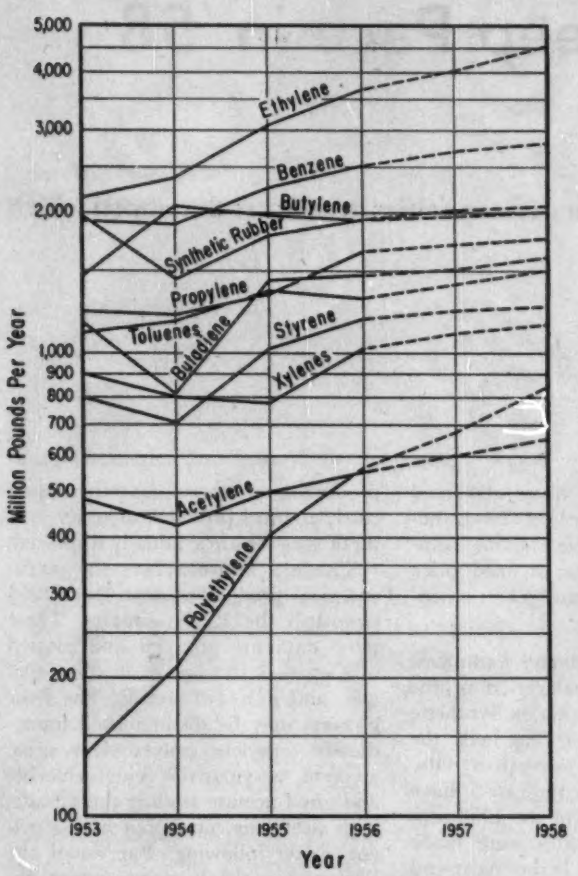

FIGURE 1—Production of hydrocarbon intermediates and polymers.

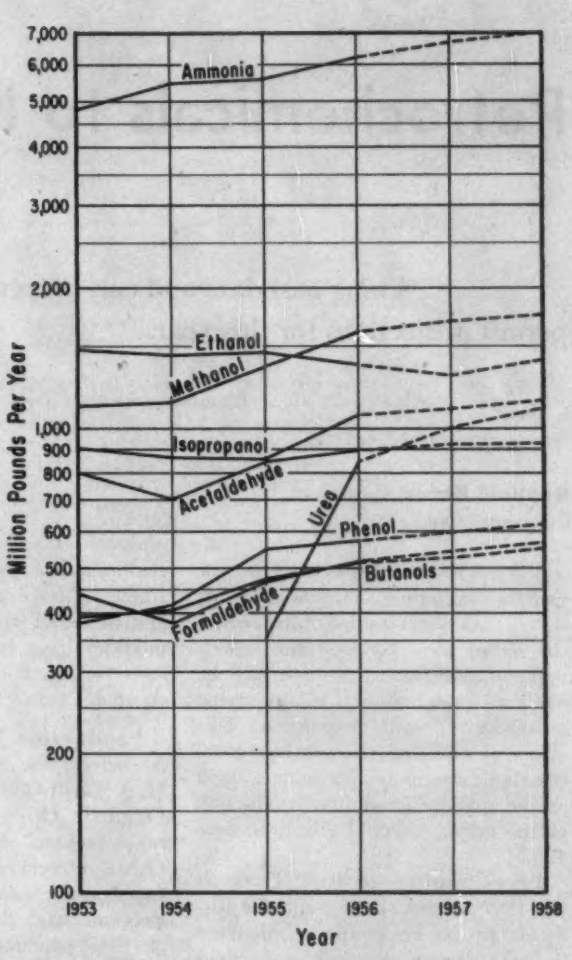

FIGURE 2—Production of phenol, ammonia, urea, aldehydes and alcohols.

the widely varying growth rates.

Hydrocarbon Intermediates

Ethylene. This primary petrochemical raw material has continued to develop its lead year after year as the number one base for major petrochemical products. New capacity is utilized as fast as it comes on stream. In some areas, the ethylene available cannot be stretched to cover all needs.

Production in 1956 of over 3600 million pounds far exceeded previous estimates, and 1957 output may exceed 4000 million pounds. Additional ethylene capacity now under construction should permit a total output of 4500 million pounds in 1958. But there will be no surplus capacity available. This indicates a need for still more ethylene in the next few years.

Propylene. Growth of propylene use has been somewhat more erratic than ethylene, decreasing in 1953-1954, taking a large jump in 1955-1956, and predicted to increase slowly again in 1957-1958. There should still be a comfortable but not excessive surplus of capacity over market requirements at the end of 1958. Development of new poly-propylene polymers may lead to a major growth in propylene production after this time. Additional production capacity would then be needed.

Butylene. This is the only major petrochemical raw material which showed a continued decrease in output from 1954 through 1956. There should be some recovery in the market in 1957-1958. Total production, however, at about 2000 million pounds per year will be considerably below plant capacity.

Butadiene. After a drop in 1953-1954, butadiene production has been climbing steadily. No major increase in growth rate is anticipated, as the dependence on the single major market, synthetic rubber, relates demand to the relatively stable new car and replacement tire market.

Acetylene. Instead of the spectacular growth predicted several years ago, acetylene has been developing slowly and steadily as a petrochemical raw material. Petrochemical capacity is being expanded by Rohm and Haas, and Dow, but the industry has noted Diamond's cancellation of its projected Texas installation. The major growth trend is toward pipe line delivery of acetylene generated from calcium carbide at large carbide plants of Linde and Air Reduction, with substantial capacity reserves available from these sources.

Benzene. Production is increasing steadily; but surprisingly, the portion made from petrochemical sources remains almost constant. This may

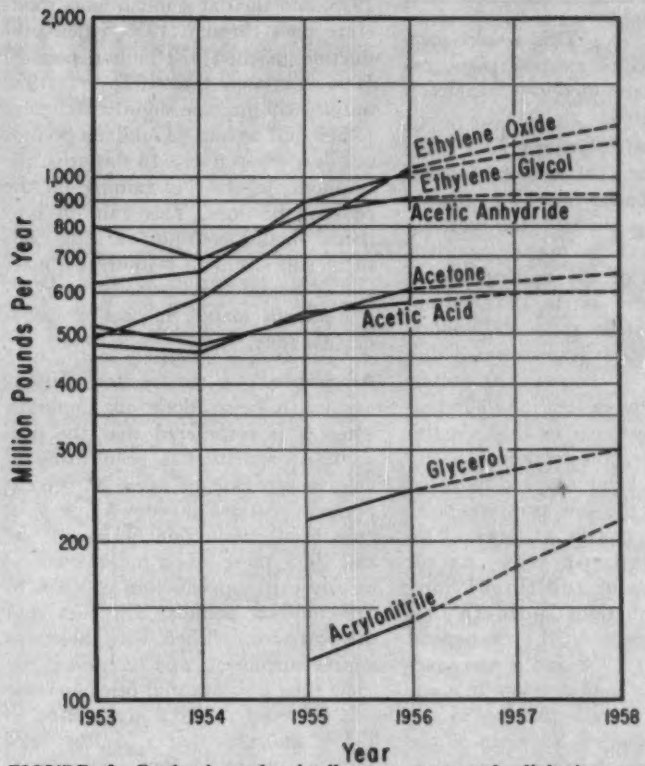

FIGURE 3—Production of miscellaneous oxgenated aliphatic compounds.

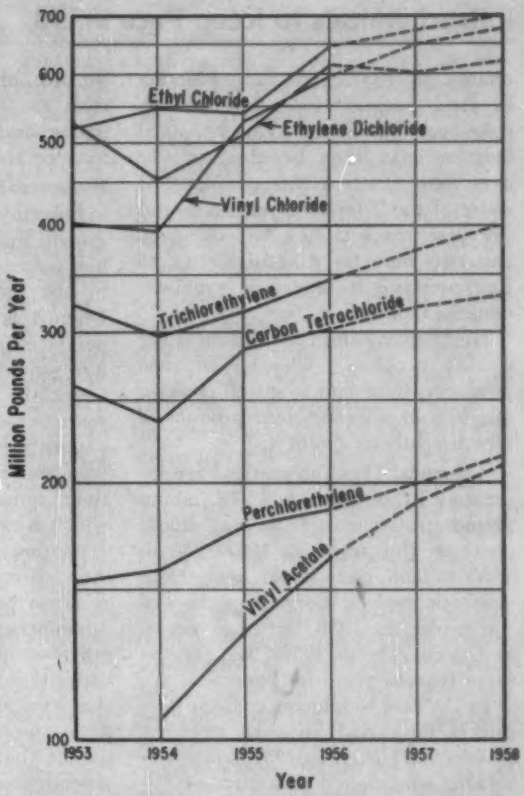

FIGURE 4—Production of chlorinated compounds and vinyls.

TABLE 2—Major Petrochemical Production and Capacity

(Millions of Pounds)

	PRODUCTION								CURRENT ESTIMATES		
	1953		1954		1955		1956		1957	1958	1958
	Total	Percent*	Total	Percent*	Total	Percent*	Total	Percent*	Production	Production	Capacity
Hydrocarbon Intermediates											
Aliphatic											
Ethylene	2136	99+	2345	99+	3048	99+	3602[3]	99+	4000	4500	4500
Propylene & Mixtures	1223	100	1204	100	1331	100	1641[1]	100	1700	1750	1900
Butylene & Mixtures	1441		2066		1960	100	1915[1]	100	1950	2000	2600
Butadiene	1152		809		1411	100	1459[2]	100	1500	1600	2200
Acetylene	480		424		500	30	550	30	600	650	1100
Aromatic											
Benzene	1900	24	1880	36	2250	32	2520[1]	33	2700	2800	3500
Toluenes	1100	75	1160	78	1340	77	1300[1]	73	1400	1500	2400
Xylenes	900	83	800	90	778	89	1020[1]	88	1100	1150	1500
Styrene	798	50	703	50	1014	50	1176[1]	50	1225	1250	1300
Hydrocarbon Polymers											
Polyethylene	135	100	210	100	402	100	566[1]	100	675	850	1200
Synthetic Rubber	1958		1435		1766	75	1920[2]	80	2000	2050	2800
Phenol	382		418	50	549	77	575	80	600	625	700
Ammonia	4800	75	5440	85	5600	90	6200[2]	90	6700	7000	10,000
Urea	....		....		350	70	842[1]	80	1000	1100	1300
Aliphatic Chemicals											
Formaldehyde (100 percent)	439		380		466		517[1]		540	570	920
Acetaldehyde	800		700		850		900		925	925	1000
Methanol	1118	80	1132	80	1359	85	1607[1]	99	1700	1750	2000
Ethanol	1475	72	1430	80	1470	83	13671,6	73	1300	1400	2800
Iso-propanol	901	100	859	100	855	100	1063[1]	100	1100	1150	1200
Butanols	392		408	52	475	53	515[1]	56	525	550	600
Ethylene Oxide	490		580		794	90	1043[1]	95	1150	1250	1300
Ethylene Glycol	624		638		828	80	1021[1]	90	1100	1150	1300
Glycerol					220	40	250	50	275	300	400
Acrylonitrile	57		63	100	118	100	141[1]	100	180	220	300
Acetic Acid	478		461	96	547	96	572[1]	96	600	600	780
Acetic Anhydride	804		691		842	96	910[1]	96	925	925	1000
Acetone	519		478	84	539	95	607[1]	96	630	650	800
Carbon Tetrachloride	280		235		287		302[1]		320	330	350
Ethyl Chloride	520		547		542	40	646[1]		675	700	....
Ethylene Dichloride	529		452		510		613[1]		600	620	....
Trichloroethylene	323		297		316		346[1]		375	400	....
Perchloroethylene	153		158		178		186[1]		200	220	....
Vinyl Chloride	402		393	80	529		597[1]		650	680	800
Vinyl Acetate			106	80	134		164[1]		190	210	....

* Percent Petrochemical Production.

change in 1957 - 1958, as reduction in steel output causes cutbacks in coke-oven operation. Petrochemical benzene may then be able to take over more than its present one-third share of the 2700-2800 million pound per year market. Reserve coke-oven capacity may be discouraging to prospective installers of synthetic benzene facilities.

Highlighting this competition is the quality problem. Coal-tar benzene producers have had to install treating facilities to upgrade their product to match synthetic quality.

Toluenes. These aromatics have increased in output to 1300 million pounds per year in 1956, and should continue this trend in 1957-1958 to 1500 million pounds per year. Here synthetic took a lesser proportion of the market in 1956, but may recoup and even gain in 1957-1958, for the same reasons given for benzene.

In the case of toluene, coal-tar producers have had an even greater problem of purity. In 1957, coke-oven toluene was quoted at a price of 1½ cents per gallon below the petrochemical product. This is small consolation, however, as even the synthetic product took a major drop. Capacity exceeds demand by about 50 percent.

Xylene recovered the ground it lost in 1953-1955 with a 40 percent increase in production to 1020 million pounds in 1956. A more moderate increase should be observed in 1957-1958, to 1100-1150 million pounds. Capacity will still exceed production by 30 percent, mainly in coal-tar plants.

Here again, the synthetic product has been a relatively fixed percentage of the market, and may gain in 1957-1958, as coke-oven production decreases. Coal-tar xylene was priced 2 cents per gallon below the synthetic product in late 1957.

Styrene. With some leveling out of synthetic rubber production, and a slowdown in rate of growth of styrene plastics (due to polyethylene and vinyl competition), styrene output growth has moderated. Reaching 1176 million pounds in 1956, after a 45 percent jump in 1955 to 1014 million pounds, a marked reduction in rate of growth is indicated. 1957 should see 1225 million pounds production, with 1250 million pounds possible in 1958. This would push close to limits of existing plant capacity, and some moderate expansion may be required.

Hydrocarbon Polymers

Polyethylene. The almost explosive growth in capacity for this hydrocarbon polymer is almost being matched by the growth in market outlets. From a level of 135 million pounds per year production in 1953, output has jumped steadily to 560 million pounds in 1956. It is anticipated that production will reach 670 million pounds per year in 1957 and 850 million pounds per year in 1958. At this time, however, production capacity which is now being sparked by rapid expansion of the low pressure polymer should reach at least 1200 million pounds per year. Recent announcements of additional Polyethylene installations indicate that capacity will be pushed even beyond this level after 1958 and a real marketing problem may develop. It is apparent that recent expansion in the polyethylene market has been at the sacrifice of some existing petrochemical plastic materials, such as polystyrene; and such inter-petrochemical competition for markets will probably develop even more strongly between the vinyl products and polyethylene.

Synthetic Rubber output has gone through a variable sequence over the period being examined. A major drop between 1953 and 1954 was followed by a somewhat slower recovery between 1954 and 1956, when production levels again reached an amount of about 1900 million pounds per year. It is anticipated that a slow steady growth will continue through 1957 and 1958 to a level of about 2050 million pounds per year, to supply the relatively stable tire market. The more glamorous new developments, such as use of synthetic rubber as a solid rocket propellant fuel is more spectacular than profitable, as the actual usage will be extremely small for some time to come. In this area too, existing plant capacity is well above existing market requirements and will probably be ample for several years to come. Possible reduction in supplies of natural rubber in the next few years could result in more complete utilization of existing capacity.

Phenol. The production of phenol increased rather rapidly from 1953 to 1955, and then at a much more moderate pace through 1956, when production reached 570 million pounds. It is estimated that 1957 and 1958 output will increase slightly each year to 600 million and 625 million pounds per year respectively. In this area, the synthetic product is gaining on the coal-tar product. This gain in synthetic should continue in 1958, but there will still be a comfortable margin of production capacity over requirements, mainly in coal-tar product capacity.

Ammonia. An outstanding marketing job is being done on ammonia, when it is considered that the production capacity has been rising at an average rate of over 20 percent per year. After a slowdown in rate of growth of production between 1954 and 1955, there was a major increase in ammonia production in 1956 to 6200 million pounds. The fact that this was accomplished when there was a large surplus of capacity, and at the same time a substantial price increase was achieved (after a major drop in 1955), indicates that a healthy agricultural market is being developed all over the country. It is estimated that this growth will continue at a moderate pace to 6700 million pounds in 1957, then 7000 million pounds in 1958.

Nevertheless, the estimated production capacity of 10,000 million pounds per year at the end of 1958 will amount to more than 40 percent over market requirements. In view of this fact, it may be surprising that announcements are still being made of new ammonia plant projects. This can only be justified in view of localized markets in which freight differentials give the local producer an advantage over a more remote shipper. In this respect, ammonia production and distribution is following somewhat the pattern of formaldehyde, where a large number of installations of moderate capacity exist all over the country, to supply local markets on a relatively short haul.

Urea. As a stable derivative of ammonia, urea has come into its own in the last three years. Starting as a major petrochemical product about 1955 at 350 million pounds per year, a major increase in output is reported for 1956 at 842 million pounds per year. As a matter of fact, this spectacular jump may not be as great as

indicated, as the earlier reporting of the U. S. Tariff Commission may not have been completely inclusive of all urea. With new urea installations going into operation and others under contract, estimated output in 1957 should reach 1000 million pounds and in 1958, 1100 million pounds. Capacity at the end of 1958 is estimated at 1300 million pounds, which is only a moderate surplus over market requirements. The greatest growth in urea output at this time results from the necessity of converting fertilizer ammonia to a stable solid product which can be stored and distributed with greater ease.

Aliphatic Chemicals. In this area, we can note the maturing of some of the older petrochemicals, particularly the aliphatic products of the C_1 and C_2 series. Many of these products are leveling out at a rate of growth parallel with that of the general economy, about 3 to 5 percent per year.

Formaldehyde. After an abrupt decrease in production from 1953 to 1954, recovery has been steady, reaching a production level of 517 million pounds per year (100 percent basis) in 1956. A further increase to 540 million pounds in 1957 and 570 million pounds in 1958 is estimated. Production capacity of over 900 million pounds per year at the end of 1958 is far in excess of requirements, but is dictated by the pattern of conversion of methanol to formaldehyde in small production units close to consumption points. Recent mention of development of a linear formaldehyde polymer indicates a possible new growth area.

Acetaldehyde has also recovered after a major drop between 1953 and 1954, to a 1956 production level of 900 million pounds per year. This figure is an estimate, necessitated by the fact that a good part of acetaldehyde production is not sold or shipped, but is converted directly in producers plants to other products. Only a slight growth to 925 million pounds per year is anticipated for production in 1957 and 1958. There is still a moderate reserve in production capacity for this product.

Methanol. Production of the lowest aliphatic alcohol increased rapidly from 1954 to 1956, to a new production record of 1600 million pounds per year. This rate of growth will probably decrease somewhat, but 1957 and 1958 should see an increase in output to 1700 and 1750 million pounds per year respectively. New facilities have been installed for synthetic methanol production, and these, when added to existing plants, should yield a capacity of 2000 million pounds per year at the end of 1958. This is a moderate surplus over market requirements.

Ethanol, of all the major petrochemicals, shows the most unusual trend in production in recent years. After a fairly stable level from 1953 to 1955, output actually dropped in 1956. This decrease in production to a total of 1367 million pounds per year is accounted for not by a decrease in market requirements, but probably by diversion of some ethylene raw material to higher profit margin derivatives, and to a shortage of molasses at a reasonable price. This production deficiency was evidently made up in imports, and in some replacement of ethanol by methanol and isopropanol.

With somewhat greater availability of ethylene and cheaper molasses in 1958, production should increase to 1400 million pounds per year, but this will still not take care of the market. It is likely that imports will again make up the balance. It should be noted that the large surplus of capacity over production indicated in Table 2 is due to existing fermentation capacity, which cannot be utilized to a large extent because of limited supplies of molasses at a competitive price.

Synthetic capacity will probably be pushed to the limit again in the next two years as more ethylene becomes available, but it will still not be able to take care of the total ethanol market. Additional synthetic facilities may be required, but may not appear attractive in view of the relatively high cost of ethylene as compared to the present price of ethanol. A price increase is indicated.

Isopropanol. This aliphatic alcohol decreased in production between 1953 and 1955, but recovered its ground and reached a new level in 1956 of 1063 million pounds per year. This rise should continue in 1957 and 1958 to a level of 1150 million pounds per year. This rise may be attributed to a major extent to the shortage of ethanol indicated above. New production facilities will exceed by only a slight amount the requirements in 1958.

Butanol output rose quite rapidly between 1953 and 1956 from 392 million pounds per year to 515 million pounds per year. The synthetic petrochemical portion of butanol production has increased steadily, too. The growth should continue at a moderate pace through 1957 and 1958 to an output of 550 million pounds per year. A moderate excess of production capacity will remain at this level.

Ethylene Oxide has shown a rapid rate of growth from 1953 to 1956 coming from 490 to 1050 million pounds per year. A slightly more moderate rate of growth is estimated for 1957 and 1958 to 1150 and 1250 million pounds per year respectively. New capacity now being installed will be in excess of 1958 requirements. Some additional facilities recently announced will probably come into operation after 1958.

Ethylene Glycol growth has also been fairly rapid, but reached a more moderate rate of rise in 1955. With an output of 1021 million pounds per year in 1956, and a slow additional increase to 1150 million pounds per year estimated for 1958, production capacity should be ample for requirements. It is interesting to note that glycol is not increasing at the rate that oxide is. In the past, the major part of ethylene oxide has been converted to glycol for anti-freeze and synthetic fiber production. New uses for the oxide in detergent manufacture and resin production are growing at a faster rate than the glycol end-use markets.

Glycerol. This old established product is growing rapidly as a major petrochemical. With shorter supplies from soap-making (now being replaced steadily by synthetic detergents), petrochemical glycerol is taking over a larger proportion of the market. In 1956 the 250 million pound per year output was 50 percent supplied from petrochemical sources. Recent announcement of expansion by Dow indicates ample capacity in 1958 for the estimated total production of 300 million pounds per year. An even greater proportion of this should be supplied from petrochemical sources.

Acrylonitrile. Synthetic fiber development is accounting for the major growth in acrylonitrile, which reached 141 million pounds in 1956, and is now completely petrochemically derived. The rapid rate of

growth should continue through 1957 and 1958 to a level of about 220 million pounds per year. Production capacity of about 300 million pounds per year at the end of 1958 should be ample to take care of the immediate market, but the rapidly growing synthetic fiber requirements will probably soon require expansion.

Acetic Acid, is one of the mature petrochemical products showing a fairly stable rate of growth. After a decrease between 1953 and 1954, there was a major recovery in 1955 and then a moderate rise in 1956, when production reached 570 million pounds. This should grow to 600 million pounds in 1957 and stay at the same level through 1958. Production capacity is well in excess of these requirements.

Acetic Anhydride. The major drop in acetic anhydride production from 1953 to 1954 was recovered in 1955, and a new level was set in 1956 when production reached 910 million pounds per year. This should grow slightly to about 925 million pounds per year in 1957 and 1958. There is a moderate excess of production capacity over this output.

Acetone. Here again the pattern of decrease in 1954 has been followed by an increase through 1956 to a level of 607 million pounds per year. Moderate additional growth in 1957 and 1958 should bring the output of this product up to 650 million pounds per year. With new synthetic sources, the total capacity is well above requirements.

Carbon Tetrachloride, after a moderate drop in production between 1953 and 1954, output jumped rapidly, reaching a level of 302 million pounds in 1956. This should increase to 320 million pounds in 1957 and 330 million pounds in 1958, pushing close to production capacity.

Ethyl Chloride, in turn, took its most rapid jump between 1955 and 1956. In the latter year, it reached a level of 646 million pounds. Moderate additional increases are estimated for 1957 and 1958, to reach 700 million pounds in the latter year.

Ethylene Dichloride is another solvent which took a major drop in 1954, but recovered rapidly, reaching 613 million pounds output in 1956. This output has probably decreased slightly in 1957, but should go up again, to a level of 620 million pounds per year in 1958. Not much further increase in volume is anticipated for this product in the near future.

Trichlorethylene. Here again, a major drop was encountered in output for 1954, but a steady recovery through 1956 brought production to 346 million pounds. Further increase is estimated for 1957 to 375 million and for 1958 to 400 million pounds.

Perchlorethylene output has increased at a steady pace from 1953 through 1956, reaching a level of 186 million pounds in 1956. A further steady increase for 1957 and 1958 is estimated to levels of 200 million and 220 million pounds per year respectively.

Vinyl Chloride output has increased at a very rapid pace particularly between 1954 and 1955. In 1956, the output of this material was 597 million pounds, and substantial increases to 650 million pounds in 1957 and 680 million pounds in 1958 are estimated. Increasing competition from polyethylene and other plastic products may reduce the rate of rise for production of this primary petrochemical, but further growth should be expected. Capacity appears to be sufficient for immediate needs.

Vinyl Acetate. A very rapid rate of rise, paralleling that of vinyl chloride, has been noted between 1954 and 1956, reaching 164 million pounds in the latter year. A major increase to 190 million pounds is estimated for 1957 and 210 million for 1958. For some time, vinyl acetate production may increase at a greater rate than that of vinyl chloride, particularly because of new acetate emulsion paints which have been developed recently.

Summary. In general, the picture developed for major petrochemical production is a promising one, although much of the bloom has gone off the rose. Many of the spectacular performers in the past have now steadied down to a fairly stable market, with only a very moderate rate of growth. In many of these cases, production capacity is well in excess of immediately foreseeable market requirements.

There are still a few fast growers, particularly those products which are primary materials for plastic and synthetic fiber use, but new process developments result in fairly rapid obsolescence of even relatively new facilities. Although expansion will be required in the future for many of these products, care must be taken that the latest developments in processes and equipment be utilized to insure a competitive position.

Raw materials are still the major controlling factor in the economics of petrochemical production, and further development of the trend towards centralized distribution facilities for the basic building units should be observed in the near future. This will apply particularly to the gaseous feeds, such as thylene, propylene and acetylene. Another trend may also be observed in the use of improved types of gas oxidation and reforming units to supply synthesis gas for some of the more complex petrochemical products, such as the higher fatty acids, alcohols and aldehydes.

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About the Author

Dr. Raphael Katzen graduated from Polytechnic Institute of Brooklyn in 1936 with a B.S. degree in chemical engineering, then received his M.S. degree in 1938 and his Ph.D. degree in 1942, both in chemical engineering from the same school. He gained a great deal of technical experience by working for Cellutate Inc., Northwood Chemical Company, Diamond Alkali, Inc., and Vulcan-Cincinnati, Inc. Early this year, Dr. Katzen organized Raphael Katzen Associates International, Inc., which consists of a group of consulting engineers and scientists engaging in consulting activities in petrochemicals and organic chemicals from Canada to Latin America. Presently he is president of this firm which is located in Cincinnati, Ohio.

Guard Against Detonation Hazards

Any plant handling flammable gases may be exposed to an explosion. Review this to see when detonation can occur and what steps you can take to prevent its violent effects.

E. L. Ghormley
The Fluor Corporation, Ltd.
Los Angeles

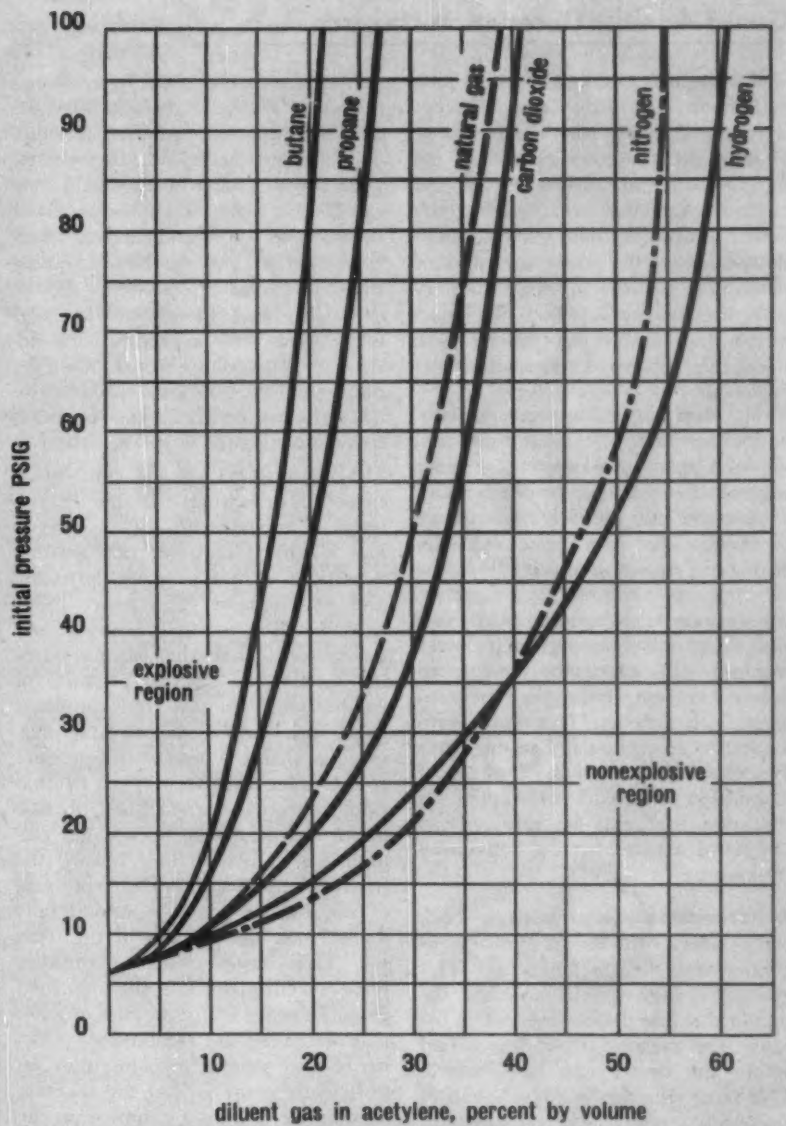

FIGURE 1—Sometimes a diluent can be added to a mixture to reduce its flammability. Here are the data for diluents in acetylene.

DISASTROUS PLANT explosions have resulted directly from a detonation type of combustion. Widespread damage can result in scattered parts of the plant because of the ability of this type of explosion to travel through pipe lines, destroying or deactivating any protective devices which may be installed in the lines.

Early in 1954 large sections of the Chemische Werke Huls plant in Germany were destroyed by a chain of explosions which started in an acetylene pipe line. Other similar explosions have occurred in both German and American plants handling acetylene or acetylene derivatives. A 10-inch crude oil pipe line in Texas was destroyed by a series of detonations that occurred when the line was being cleaned, using compressed air. In this case 26.8 miles of line were destroyed by a series of explosions that traveled the entire distance at an average speed of about 296 feet per second.[3]

Industrial piping systems handling flammable gases mixed with air or oxygen, or unstable gases such as acetylene even in the absence of oxygen, may be exposed to a detonating type of explosion. Every precaution should be taken in the plant design to preclude the possibility of detonation.

In systems which normally handle combustible gases or acetylene-like compounds and in which the possibility of detonation exists the piping should be checked to determine if it is sufficiently strong to contain the detonation. In such hazardous service, piping and associated equipment should be designed to withstand a detonation to the maximum degree that is possible. Where the piping cannot be designed to contain a detonation, the lines should be isolated. All systems subject to detonation should have detonation barriers installed in the interconnecting piping to limit the extent of damage.

Ordinary burning can occur within

well designed piping and processing equipment with little damage except that caused by the high temperatures. If high pressures develop during the burning, standard safety valves and rupture discs will usually give sufficient protection. However, when a detonation occurs, these measures of protection, if used in the customary way, are inadequate. Both flame arrestors and rupture discs have proved unreliable against a detonation-type explosion.

The data in the literature on detonation are limited in that they consist of either laboratory tests under controlled conditions, or observations of plant explosions which already have occurred. The data presented here have been drawn primarily from the former source, and the data from investigations on commercial plant scale equipment have been given primary emphasis. Therefore the conclusions drawn here may be applied to commercial plant design. This report is intended to give plant design engineers some familiarity with the problem of detonation along with information on the steps that may be employed to safeguard a plant from a detonating explosion.

A detonation is a pressure or shock wave which travels at velocities greater than the speed of sound. This extremely high velocity makes the standard safety devices ineffective because the pressure front has passed before the device can be actuated. This same situation is encountered in electrical circuits where a circuit breaker fails to operate in time to protect equipment from a lightening strike.

The scope of this report is necessarily limited and will cover only the combustion of gases and dust suspensions. Generally speaking, the detonation of a liquid or solid explosive is much more destructive than the detonation of a gaseous fuel. Even though the same chemical reaction may occur, as in the decomposition of liquid and gaseous acetylene, the greater mass concentration in the liquid state causes this type of explosion to be considerably more destructive. However, the hazards involved in handling liquid and solid explosives are for the most part well known and are normally taken into account in the design of processing plants. On the other hand the gas phase type of detonation is less generally known and is frequently ignored in plant design.

A detonation type of combustion can occur only when a flammable material is mixed with air or oxygen and is ignited under certain limiting conditions of temperature, pressure, and environment. The basic difference between normal burning and detonation is that when normal burning occurs, the gaseous products of combustion flow away from the flame front, and have a density and pressure less than the density and pressure of the unburned gases. When detonation occurs, the burned gases, because of the inertia of the burned gas column, are caused to flow toward the fresh unburned gas, and the pressure of the burned gases is substantially higher than the pressure of the fresh gas. This action creates a pressure wave which moves into the unburned gases. In order that a mixture of gases may detonate, the combustion velocity of the gaseous mixture must be sufficiently great so that the reaction is complete or almost complete in the wave front. If this condition is not achieved, rapid combustion may occur, but a detonating type shock wave will not be established.

Materials subject to detonation are mixtures with air of vapors such as hydrogen, ethyl ether, methane (in motion), fuel gas, ethylene, ethyl alcohol and gasoline. Suspensions of flammable dusts such as magnesium, aluminum, cork, starch, coal, flour, and sugar have also been shown to exhibit detonation type of combustion in air.[9] A much larger group of hydrocarbons and combustible gases will detonate through a wider range of mixtures when mixed with pure oxygen. However, this condition is not frequently encountered in industrial practice, and will not be considered here, although the general conclusions reached are equally applicable to these mixtures.

Acetylene is one material that is particularly subject to detonating explosions. Mixtures of acetylene and air will detonate readily when ignited in a tubular container. When mixed with oxygen, acetylene will detonate through an even wider range of fuel mixtures. In addition acetylene gas is subject to two types of spontaneous decomposition in the absence of any oxygen: One form is known as slow decomposition where acetylene dissociates in the form of a flame front which progresses slowly through the gaseous mixture. The other form of decomposition occurs as a true detonation where the flame front travels at velocities from 3000 to 5000 feet per second through the gas. Compounds which contain acetylene as the basic molecule such as monovinyl acetylene and divinyl acetylene exhibit somewhat similar properties.

For most combustible materials there is a definite concentration range through which detonation can occur, just as there is a wider concentration range through which normal burning can occur. Tables 1 and 2 show the concentrations which limit detonation for a number of chemical compounds. The flammability limits for normal burning of these same materials are also shown for comparison. These results have been reported by numerous investigators, and for the most part are limited to tests run at atmospheric

TABLE 1
Gases Mixed With Air

GAS	Flammability Limits % by Volume		Detonation Limits % by Volume		References
	Lean	Rich	Lean	Rich	
Hydrogen	4.1	74.2	18.2	58.9	(2) (5)
Acetylene	2.5	80.0	4.2	50.0	(2) (5)
Methane	5.3	13.9	8.5	11.0	(2) (10)
Ethylene	3.02	34.0	9.1		(2) (18)
Gasoline	1.3	7.3	2		(17) (18)
Diethyl Ether	1.7	48.0	2.8	4.5	(2) (5)

TABLE 2
Gases Mixed With Oxygen

GAS	Flammability Limits % by Volume		Detonation Limits % by Volume		References
	Lean	Rich	Lean	Rich	
Hydrogen	4.6	93.9	15.0	90.0	(17) (5)
Acetylene	—	—	3.5	93.0	(5)
Methane	5.4	59.2	10.0	56.0	(17) (18)
Propane	—	—	3.7	37.0	(5)
Hexane	—	—	2.0	13.0	(20)
Diethyl Ether	2.10	82.0	2.6	>40.0	(17) (16)
Carbon Monoxide	15.5	93.9	38.0	90.0	(17) (5)
Ammonia	19.0	70.0	25.4	75.4	(13) (13)

pressure, and at static conditions. Temperature and pressure have a considerable affect on the flammability limits of gases, and these limits would be subject to change at other conditions of temperature or pressure.

Unforunately there is insufficient information describing materials subject to detonation. In the absence of specific information, the plant engineer should be particularly suspicious of materials with a wide range of flammability, compounds that contain a triple bond, or compounds that contain acetylene. Such materials may not detonate when tested under laboratory conditions, and yet they may be subject to detonation under specific plant conditions of temperature, pressure, or motion. Further investigation of the detonating properties of chemicals will help to clarify the groups of materials that are subject to detonation.

Turbulence of the mixed gases has been shown to affect the limits of detonation. Henderson[10] has shown that static mixtures of methane and air at atmospheric pressure do not detonate when ignited in a 4-inch pipe. However, when the same gases are flowing through the pipe at a velocity of about 16 feet per second detonation can occur. Stoichiometric mixtures of natural gas and air will detonate at pressures as low as 0.2 atmospheres when flowing at a velocity of 70 feet per second.[7]

To design for protection against the hazards of detonation, it is necessary to examine the materials being processed which might be subject to detonating explosions, the processes employed, possible sources of ignition, and over-all plant layout. The hazard of detonation must be considered both in the design of special pieces of equipment, and in the equipment arrangement. It is not practical to design major items of equipment to withstand the pressures that might be reached in a detonation type explosion, but it is possible to limit the sources of ignition, and to restrict flame propagation by means of suitable barriers, and thus restrict the damage incurred. Over-all plant layout must also be considered. Suitable space or rugged physical barriers should be provided to isolate hazardous areas and equipment. A compact plant design is not only undesirable but actually hazardous if the explosion of one unit could break equipment and start fires in other units located nearby.

The sources of ignition that are primarily responsible for detonations are those which might occur inside a vessel or process line. Exterior sources of ignition could also cause burning at an open vent, and this could progress into the pipe to become a detonation. However these sources of ignition are generally recognized and suitable precautions taken.

Possible internal sources of ignition include static electrical sparks, oxidizing catalysts, metallic acetylides, reduced iron, iron sulfide, and unstable chemical compounds such as peroxides. Sometimes it is possible to eliminate such hazards by selecting specific materials of construction, but more often the hazard is inherent in the process, and ignition can occur if any air gets into the system. Often a change in processing conditions will permit operation outside of the detonation limits. Sometimes a diluent substance can be added to the mixture to reduce the flammability of the mixture. Figure 1 shows the minimum concentrations of various gases required to prevent explosions of gaseous acetylene in the absence of air. Metallic catalysts can be exposed to air safely if oxidation is carried out under controlled conditions in a non flammable atmosphere. Steps such as these are mandatory to minimize the possibility of detonation within a plant.

Industrial piping is normally not designed for pressures of the order of magnitude encountered in a detonation, and in most cases it would not be practical to do so. However, detonations in industrial piping can result from misoperation or malfunction of equipment, or from some unusual condition outside of the normal range of operating conditions. Where there is possible it is desirable to design the piping to withstand a detonation.

All lines containing combustible mixtures or acetylene and where there is a real possibility of detonation, should be checked. Pilot plant piping is possibly more likely to be exposed to a detonation than commercial plant piping. Small lines are usually capable of resisting a detonating explosion which is initiated at atmospheric pressure, but in the larger line sizes the detonation pressure may exceed the maximum ultimate strength of the line. By determining the design strength of a section of pipe it is possible to properly plan for whatever protective measures need to be taken. Where piping will contain the explosion, it is only necessary to provide suitable detonation barriers in the piping system. However, if it is found that the detonation pressure is sufficient to rupture the pipe, and where it is impossible to provide piping of adequate strength, the hazardous piping should be isolated from other lines and equipment.

It is usually possible to either calculate or measure the maximum pressure that will be generated in a given detonation. For example, Figure iii in the accompanying box could be used to estimate the maximum radial pressure that would occur in a system processing methane. This maximum pressure can then be used as a design pressure for the equipment or piping in the system. The following calculation may be used to determine if a given pipe will contain the explosion:

Assume a 10 percent mixture of natural gas in air at 40 psig. The peak detonation pressure at this condition is about 5000 psig. Calculate the pipe thickness required to contain this detonation in a 4" carbon steel (A-106B) pipe.

$$t = \frac{PD}{2S_y}$$

where t = pipe wall thickness inches
P = internal pressure psi
D = pipe outside diameter
S_y = yield strength of pipe = 35,000 psi for A-106B

$$t = \frac{(5000)\ (4.5)}{(2)\ (35{,}000)} = 0.322$$

Schedule 80 seamless pipe has a thickness of 0.337 inches and would be capable of containing the detonation. The yield strength of the pipe is used in this calculation because this stress limit will provide sufficient strength to contain the explosion. A more conservative design basis may be used where recurring detonations are anticipated.

This calculation considers the hoop stress in the pipe, and is based on the radial pressure of the detonation wave. Where elbows are used, the stress may be somewhat greater due to the impact pressure of the wave. However, the axial strength of a pipe subjected to internal pressure is twice the radial strength, which tends to compensate for this effect. Long radius ells should be used to minimize the impact stress on pipe at bends.

If the detonation pressure is sufficiently high to cause a line to fail, the line may burst at several places as the detonation passes down the line.

In such cases it is probable that the detonation wave is disrupted at each break in the line, and a period of pre-detonation burning is required before the maximum detonation pressure is again reached. Such an explosion moving through a plant can cause widespread damage.

Pressure relief is no protection from detonation. Under normal operating conditions when a uniform pressure prevails throughout a system, relieving devices such as relief valves and rupture discs perform quite satisfactorily and will protect a system from over-pressure. However, the pressure in a detonation wave is not affected by the piping that precedes the wave. The wave velocity is so high that the unreacted gas is not affected until it is compressed by the shock wave. Consequently, relief valves in the line do not protect the line from the peak pressure, but open only after the peak of the wave has passed. When a system protected by a rupture disc is exposed to a detonation, the piping is exposed to peak detonation pressure regardless of the thickness of the rupture disc.

In one series of tests detonations were carried out in a line to which

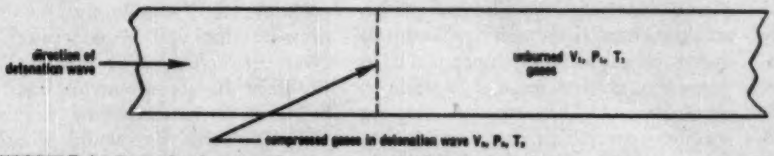

FIGURE i—In a shock wave the extremely high velocity of the moving gases creates a compression resulting in a very high temperature.

What Is a Detonation Wave?

THE PROPAGATION OF A DETONATION WAVE may be easier understood by first understanding the principles behind the generation of a shock wave. Referring to Figure i; v_1, p_1 and T_1 are the specific volume, pressure and temperature of uncompressed gases. Considering the shock wave to be stationary, let u_1 be the velocity of the fresh gas relative to detonation wave, and u_2 be the velocity of the burned gases relative to the wave front. Subscript 2 refers to the condition of the gases after compression in a shock wave. Using 1 pound of gas as a basis, and applying the law of Conservation of Mass:

$$\frac{u_1}{v_1} = \frac{u_2}{v_2} \qquad (1)$$

The momentum of the moving gas is $\frac{u^2}{v}$, and pressure of the gas is equal to the momentum of the gas transmitted by molecular impacts per unit area. Therefore, a momentum balance across the shock wave gives:

$$\frac{u_1^2}{v_1} + p_1 = \frac{u_2^2}{v_2} + p_2 \qquad (2)$$

An energy balance gives the third relationship required to calculate an equation for a shock wave.

$$E_1 + \frac{u_1^2}{2} + p_1v_1 = E_2 + \frac{u_2^2}{2} + p_2v_2 \qquad (3)$$

From these equations the Hougoniot equation can be derived which permits us to calculate conditions in the shock wave.

$$E_2 - E_1 = \frac{1}{2}(p_1 + p_2)(v_1 - v_2) \qquad (4)$$

This equation is similar to the equation for a reversible adiabatic compression where the pressure differential or the gas velocity is low. However, in a shock wave the extremely high velocity of the moving gases create an irreversible compression, and the resulting temperature is much higher than would result from an adiabatic compression. For example, if air (assumed to be a perfect gas) is compressed to 50 atmospheres, the reversible adiabatic compression temperature would be 900°F, whereas the irreversible shock wave compression temperature calculated from the above equation is 3,390°F.

When combustion is very rapid the products of cobustion are compressed, and the inertia of the burned gases causes a net gas flow in the direction of the unburned gas. This movement of the burned gases causes the fresh unburned gases to be compressed, and the reaction appears as a shock wave which progresses at a velocity equal to or greater than the speed of sound. When the burning velocity of the gases is sufficiently rapid to accompany this shock wave, the resultant combustion is known as a detonation. It is possible to calculate the properties of a detonation resulting from combustion based on the heat of reaction of the gases, and examples of this may be found in the literature. (7, 13, 17, 20)

A radial pressure is exerted by a detonation wave against the sides of the vessel through which it is passing. This can be calculated by Equation 4. This pressure is a fluid pressure due to the burning and compression of the gases. If the detonation wave meets an obstruction, the hydrostatic pressure is combined with the directed impulse of the gases moving with the wave front. The velocity of the gases following the shock wave is

$$w = u_1 - u_2 = (v_1 - v_2)\sqrt{\frac{p_2 - p_1}{v_1 - v_2}} \qquad (5)$$

and the impulse of these gases is

$$\frac{w^2}{v_2} = \frac{(v_1 - v_2)^2}{v_2}\left(\frac{p_2 - p_1}{v_1 - v_2}\right) = \left(\frac{v_1 - v_2}{v_2}\right)(p_2 - p_1) \qquad (6)$$

Then the total impulse of the shock wave (i) becomes:

$$i = p_2\,p_1\,(p_2 - p_1)\left(\frac{v_1 - v_2}{v_2}\right) = p_2 - p_1\left(\frac{v_1}{v_2}\right) \qquad (7)$$

This pressure effect is called the axial pressure of the detonation wave. The wave front is very thin, and therefore the impulse is exerted only briefly. Axial pressures vary from 1½ to 3 times the radial pressure in the usual range of detonations encountered in industrial equipment.

A period of inception occurs after a combustible mixture is ignited, before a detonating wave is established. The length of this period of pre-detonation is influenced by several factors including fuel concentration, pressure, pipe diameter, additives, etc. The period of pre-

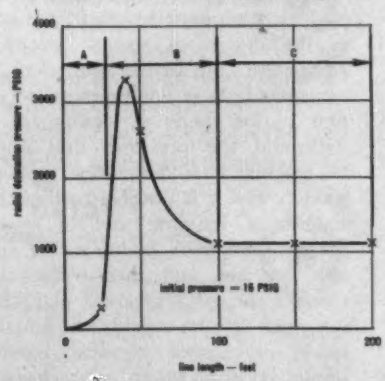

FIGURE ii—When detonating a mixture of methane and air in a pipe line, a period of inception occurs before the peak detonation wave is formed.

various protective devices were attached. In all tests the same pressure resulted in the line regardless of the bursting strength of the rupture disc. In one test a piece of paper was substituted for a rupture disc, and when detonation occurred the same peak pressure resulted in the line.[18] This result is easy to understand in view of the high velocities involved in wave propagation, and the relatively low velocities of gas movement.

Numerous other investigators have carried out similar tests, and in all cases the same conclusion could be drawn; namely, that *pressure relieving devices afford no protection from detonation pressures.*

Flame arrestors are not reliable for detonation protection. The first apparent solution to the problem of detonation is to use a flame arrestor in the line to stop the reaction. Many different types of flame arrestors have been designed to prevent the passage of flame through industrial piping. Such arrestors are quite efficient in stopping normal burning, and have been used effectively for many years. However, when this type of flame arrestor of relatively light construction is exposed to shock wave with an impulse pressure of several thousand pounds per square inch, severe damage to the flame arrestor will result and failure is likely to occur.

Most commercial arrestors consist of screens, tubes, or corrugated plates

detonation increases as pipe diameter increases, and decreases with increasing pressure.

Another factor that affects the pre-detonation time is roughness of the internal surface of the pipe. If the inside of the pipe is rough, or if there is any discontinuity or restriction in the pipe, the time required to reach detonation velocities will be reduced. This fact has been observed in many different laboratory tests, and observations of plant explosions have shown that detonation was initiated following an obstruction in a pipe line. Where slow decomposition of acetylene occurs in a line, and continues to some obstruction such as a perforated screen, it may be converted at the screen into a detonation reaction. This same occurrence has been observed in tests on commercial flame arrestors, and also in some cases where the decomposition passed through a section of line filled with packing material.

Wave propagation may be demonstrated for a mixture of gases capable of detonation by igniting it at one end of a tube. The burning will progress down the tube and the flame wave will accelerate until it reaches detonation velocity. This velocity may vary from 1000 to 5000 feet per second. The pressure at the flame front increases as the flame velocity increases until it reaches a maximum. This point is substantially higher and may be as much as several times higher than the pressure exerted by the same wave after it has reached a steady state condition.

Figure ii shows the variation of radial pressure resulting from the detonation of a mixture of methane and air.[10] This curve illustrates very clearly the three phases of generation of a detonation wave: Zone A is the pre-detonation period during which acceleration to detonating velocities take place; B is the unstable peak of the detonation wave during which both pressure and flame velocity may reach a maximum; and Zone C represents a stable detonation wave in which flame velocity and pressure remain essentially constant. However, not all gaseous mixtures exhibit a peak in pressure.[18]

The velocity of a detonation wave increases as the initial pressure is increased. Based on studies of the detonation of stoichometric mixtures of hydrogen and oxygen at reduced pressure Kistiakowsky reports that the reaction rate varies as the square of the initial pressure.[14] If this relationship is extended from the experimental limits up to one atmosphere pressure, the reaction would last only 10^{-6} seconds. This relationship of reaction rate to pressure helps to explain why gaseous mixtures which will not detonate at atmospheric pressure will detonate when ignited under pressure.

Both the peak and the steady state detonation pressures are affected by the initial gas pressure. Both pressures are approximately proportional to the pressure of the unburned gases. This effect is shown in Figure iii which shows the variation of peak and steady state detonation pressures as a function of initial pressure for mixtures of methane and air. Detonation took place while the gas was in turbulent flow, and the pressures measured were radial pressures. Similar correlations can be drawn for other gases except that the slopes may vary slightly.

Since the action of the burned gases pushing against the flame front is required to generate a detonation wave, it is not possible for a detonation wave to persist in open space or in a large vessel. However detonation waves have been observed in lines as large as 24-inches in diameter.[7] Detonations also are known to have passed through lines as small as ½-inch in size.

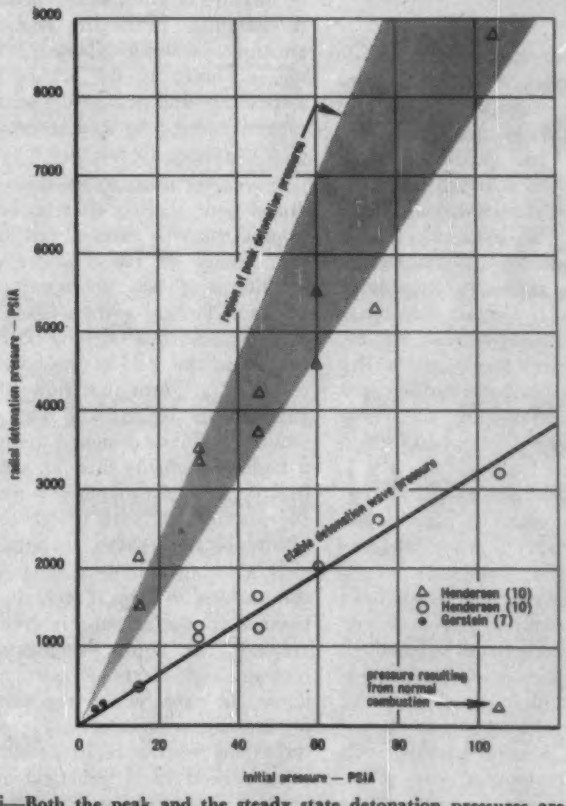

FIGURE iii—Both the peak and the steady state detonation pressures are affected by the initial gas pressure.

so arranged to make the gas flow through numerous small passages. These passages are sufficiently small to prevent flame propagation through the interstices. A flame arrestor functions by cooling of the burning gases to a temperature that is low enough to prevent further flame propagation. This principle is incorporated in the design of commercial arrestors where a tube bundle or screen absorbs heat to prevent flame passage. However, these units will permit a flame to pass through if combustible gases are permitted to burn for a considerable period of time at the surface of the element.

Commercial flame arrestors can serve in specific locations to protect a plant from detonation. A flame arrestor located at the *end* of a line through which flammable gases are being discharged to the atmosphere can effectively prevent the passage of flame into the line if burning does not continue for too long a time. By preventing pre-detonation combustion, the flame arrestor protects the line from the formation of a detonation wave.

Detonation Barriers can be made of flame arrestors if they are constructed strong enough to withstand the impact of detonation waves. Vessels filled with various packing materials have been tested as flame arrestors, and some materials have been proven to be quite effective in stopping both burning and detonation. It is of course necessary to provide sufficient mass to quench the flame and to prevent over-heating of the packing. An ideal flame arresting packing will have a large surface area and small interstices. At the same time it must offer a low resistance to the flow of gases.

Figure 2 represents a typical detonation barrier used in conjunction with a rupture disc to relieve the system pressure. The vessel is packed with 1-inch Raschig rings which have been used effectively to stop acetylene detonations. If such a unit is installed, the packing depth should not be less than 10 feet, and in large diameter units a depth of 12 to 18 feet should be used. Use of a metal packing such as steel Raschig rings, is more effective than stoneware because of its resistance to impact breakage and because of its greater heat conductivity.

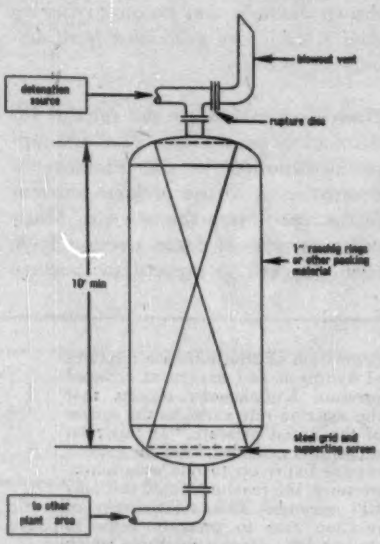

FIGURE 2—Vessels filled with various packing materials have been tested as flame arrestors and have proven to be effective in stopping both burning and detonation.

Before any given packing is installed in a plant, actual detonation tests should be run using the specific gas or mixture of gases to be encountered to determine if the size and type of packing is suitable. (Note: No packing is known to the author that is sufficiently fine and at the same time rugged enough to stop a detonation of a hydrogen-air mixture.)

A word of warning should be introduced here, namely that packed barriers of this type can still fail to arrest the passage of flame under certain conditions of flow, temperature, and pressure. Failure is most likely to occur where normal burning occurs and persists at one end of the barrier because of a continuing flow of fresh gas through the packing. The packed section should be designed to maintain a high gas velocity through the packing to prevent prolonged burning in the packing. By such design the possibility of failure can be minimized.

If a liquid can be circulated over the packing to keep it wet, the effectiveness of the arrestor is greatly increased. The liquid provides surface cooling, and effectively quenches the flame. In cases where the possibility of detonation is extremely great, installations with a recirculated liquid have proved to be practical and reliable. Frequently a process installation such as a packed tower or scrubber will serve as a detonation barrier in addition to performing its normal process function. Detonation arrestors of the type described above have been successfully tested and used in this country and in Germany.[1]

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About the Author

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From 1947 to 1950 he was associated with the consulting engineering firm of George Armstead, Jr. in Washington, D. C. From 1950 to 1952 he was with the Gas Processes division of the Girdler Corporation, and in 1952, he joined Fluor where he has worked on many major projects.

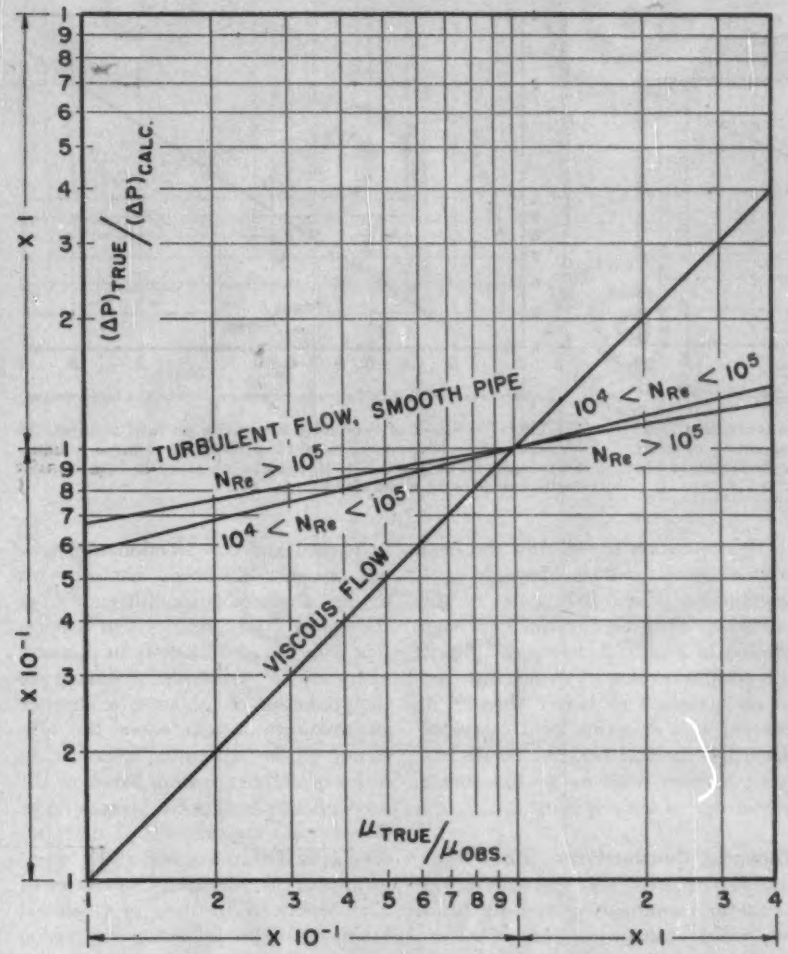

FIGURE 1—Effect of viscosity on pressure drop showing the inaccuracy introduced into the pressure drop calculated as a function of a deviation in the viscosity.

How Transport Data Accuracy Affects Design

Accuracy in process design calculations is only as precise as the viscosity, thermal conductivity, and diffusivity data used.

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The M. W. Kellogg Company, New York City

THE TRANSPORT properties of gases are used by engineers in the design of equipment to carry out the various unit operations which are assembled into an integrated process. Fluid flow, heat transfer and distillation are the most important of these unit operations. The accuracy of the gaseous transport properties used in these operations should be evaluated.

Viscosity, thermal conductivity and mass diffusivity are the most useful properties for the present-day designer. The designer's requirements of accuracy, temperature and pressure for current engineering purposes will be discussed.

Viscosity. The most common and perhaps oldest application of a transport property in the field of chemical engineering is viscosity. The first application of the property was probably by Reynolds in his study of fluid flow. From this beginning we have progressed to modern fluid mechanics and its application to chemical engineering. The most frequent use of viscosity is in the sizing of pipe so that an optimum economic balance may be realized between the cost of pipe and the cost of compression power required to move the desired quantity of gas. The relationship for calculating the pressure drop is the well-known formula

$$\Delta P = \frac{2fLu^2\rho}{gd}$$

where d = pipe diameter, ft.
f = friction factor.
g = gravitational constant, ft/sec.^{2}
L = length of pipe, ft.
ΔP = pressure drop, lbs/sq ft.
u = gas velocity, ft/sec.
ρ = gas density, lbs/cu ft.

The friction factor, f, has been correlated as a function of Reynolds number $(du\rho)/\mu$, where μ is the viscosity, in lbs/ft sec. Many correlations exist giving this relationship but the most recent and most widely accepted today in the process industries is that of Moody.[1] Moody's correlation was used as the basis for this study of the accuracy required in viscosity for sizing of pipe.

Figure 1 shows the inaccuracy introduced into the pressure drop calculated as a function of a deviation in the viscosity for smooth pipe in both the turbulent and viscous flow regions. If we assume that we wish to know the viscosity to an accuracy that will not introduce more than a 10 percent uncertainty in the calculated pressure drop due to viscosity alone, then it is seen that viscosity may vary from 0.65 to 1.75 times the true value when the Reynolds number is greater than 10^5. When the Reynolds number is between 10^4 and 10^5 this tolerance range becomes from 0.52 to 1.55.

In the turbulent region these ranges represent the most stringent require-

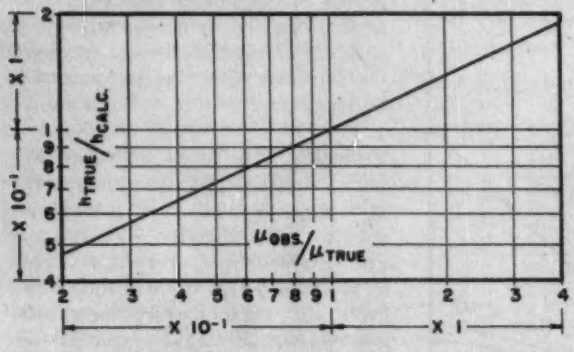

FIGURE 2—Effect of viscosity on heat transfer (turbulent flow). Notice that viscosity must be known to an accuracy of better than ±20 percent if a criterion of 10 percent deviation in heat transfer coefficient is to be met.

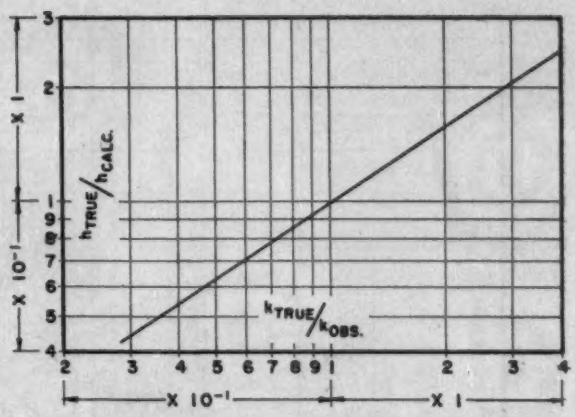

FIGURE 3—Effect of thermal conductivity on heat transfer. An accuracy of —18 percent to +13 percent in thermal conductivity must be obtained if ±10 percent accuracy in heat transfer coefficient is to be maintained.

ments for accuracy of the viscosity figure. The range of acceptable inaccuracy is widened as the relative roughness of the pipe increases until the point is reached at which viscosity has no effect on the pressure drop. This occurs in very rough pipe in which there is fully developed turbulence.

The viscous region is of very little importance in the design of piping for gaseous systems because the low viscosity usually confines flow to the turbulent regions for most commercial applications. However, just as a matter of interest, a line for this region is included in Figure 1. It is seen that the pressure drop is directly proportional to the viscosity and that a ±10 percent accuracy in viscosity would be required to be assured of a ±10 percent accuracy in pressure drop.

The next most important application of viscosity is in the following relationship of Colburn[2] which gives the turbulent heat transfer coefficient in terms of the properties of the flowing gas.

$$\frac{h}{cG}\left(\frac{c\mu}{k}\right)^{2/3}=\frac{0.023}{\left(\frac{dG}{\mu}\right)^{0.2}}$$

where c = specific heat, Btu/lb °F.
d = tube diameter, ft.
G = mass velocity, lbs/hr sq ft.
h = heat transfer coefficient, Btu/hr sq ft °F.
k = thermal conductivity, Btu/hr sq ft °F/ft.
μ = viscosity, lbs/ft hr.

When this equation is solved to find the effect of viscosity, the following expression is obtained:

$$h_{true}=h_{calc.}\left(\frac{\mu_{obs.}}{\mu_{true}}\right)^{0.467}$$

This equation shows that the heat transfer coefficient is inversely proportional to the 0.467 power of the viscosity. This equation has been plotted in Figure 2. From this figure it is seen that viscosity must be known to an accuracy of better than ±20 percent if a criterion of 10 percent deviation in heat transfer coefficient is to be met, due to an inaccurate knowledge of the viscosity.

Thermal Conductivity. This heat transfer equation also gives the effect of thermal conductivity on heat transfer, which constitutes the most important use of gaseous thermal conductivity in the process industries. The solution of the equation, plotted in Figure 3, gives the following effect of thermal conductivity on heat transfer:

$$h_{true}=h_{calc.}\left(\frac{k_{true}}{k_{obs.}}\right)^{2/3}$$

Because the heat transfer coefficient is proportional to the 2/3 power of the conductivity, an accuracy of —18 percent to +13 percent in the thermal conductivity must be obtained if a ±10 percent accuracy in heat transfer coefficient is to be maintained.

Diffusivity is just becoming an important transport property in the design of process equipment.

Its prime use has been in correlating and predicting the performance of diffusion processes, of which distillation is the most widely used and perhaps best understood. But even here our knowledge is sketchy and somewhat uncertain.

Due to the complex relationships of hydraulics, contact time and mixing in packed and tray fractionating towers, no reliable method has yet been devised for predicting efficiency from the tower layout and system properties. The use of diffusivity in this unit operation is primarily restricted to the prediction of contact efficiency for an unknown system when the efficiency of the apparatus is known in terms of another system. Much of the work on tray towers has been done by Gerster and coworkers[3,4] at the University of Delaware under the sponsorship of the Research Committee of The American Institute of Chemical Engineers. The following expression relates efficiency to gas- and liquid-phase transfer units:

$$-\frac{1}{ln(1-E_{OG})}=\frac{1}{N_G}+\frac{m(G_m/L_m)}{N_L}$$

where E_{OG} = Murphree point efficiency.
G_m/L_m = ratio of gas to liquid flows, in moles/mole.
m = slope of the equilibrium curve.
N_G = number of gas phase transfer units.
N_L = number of liquid phase transfer units.

While this expression does not contain any gas transport properties, the prediction of the value of N_G is dependent upon a correlation between N_G and the Schmidt number, $(\mu/\rho D)$:

where D = diffusivity, sq ft/hr.
μ = viscosity, lbs/ft hr.
ρ = density, lbs/cu ft.

The number of gas phase transfer units has been correlated as inversely proportional to the ½ power of the Schmidt number and therefore is directly proportional to the ½ power of the diffusivity and inversely proportional to the same power of the

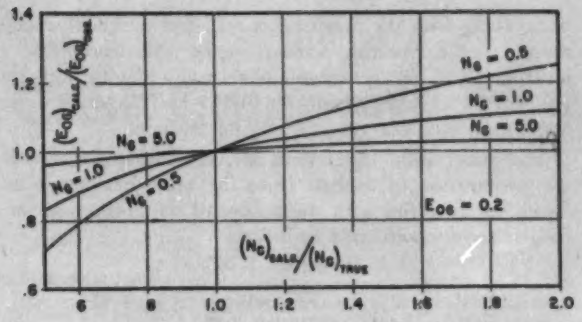

FIGURE 4

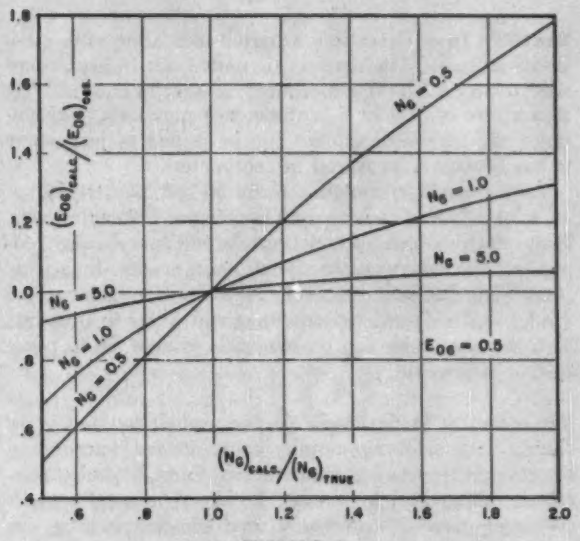

FIGURE 5

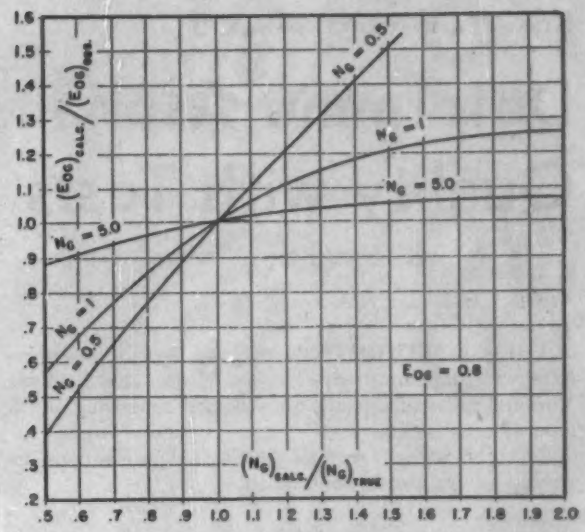

FIGURE 6

These diagrams show effect of N_G on Murphree point efficiency. Observe that good accuracy of transport properties is less important at low than at high efficiencies.

viscosity. Therefore, if we examine the effect of changes in N_G on the over-all efficiency, we will be able to assess the influence of diffusivity and viscosity on the Murphree point efficiency.

Figures 4, 5 and 6 present the changes in Murphree efficiency as a function of the inaccuracy of the number of gas transfer units and the absolute value of the number of gas transfer units and the efficiency. From these charts it may be observed that good accuracy of transport properties is less important at low than at high efficiencies. Table 1 was prepared from the charts to illustrate the deviations in diffusivity and viscosity corresponding to the permissible deviations in the number of transfer units at a true value of $N_G = 1.0$. The comparison is made at $E_{OG} = 0.2$ and 0.8.

Interpreting the figures of Table 1 in terms of process significance for absorbers, where the liquid film is usually controlling and low efficiencies are the rule, a very low degree of accuracy is permissible for the transport property. In distillation, gas film usually controls and high tray efficiencies are usually met. In such cases accurate properties are required.

TABLE 1

Accuracy Required for Prediction of Murphree Point Efficiency Within ±10%

E_{OG}	True N_G	DEVIATIONS		
		N_G (True—Calculated) Percent of True Value	Diffusivity (True—Calculated) Percent of True Value	Viscosity (True—Calculated) Percent of True Value
0.2.....	1.0	−75 to +35	−206 to +58	+67 to −135
0.8.....	1.0	−17 to +15	− 37 to +28	+27 to − 38

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Know Your Asphalts—Part 5

Determine Asphalt Quality with Tests

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THE CONSTRUCTION of good asphalt pavement requires compliance with state highway specifications. Various grades of asphalts are specified depending on the type of construction.

Recently revised Asphalt Institute Specifications for paving grades are shown in Table 1.

TABLE 1
Revised Paving Asphalt Specifications

Grade	60–70	85–100	120–150	200–300
Penetration, 77 F	65	90	130	150
Flash, open, F	450+	450+	425+	350+
Loss on heating, percent (Five hours at 325 F)	1	1	2	2
Penetration after loss test (Percent of original)	70+	70+	70+	60+
Ductility, Grams:				
At 77 F	100+	100+	60+	...
At 60 F	....	....	....	60+
Solubility in carbon tetrachloride, percent	99.5+	99.5+	99.5+	99.5+

Tests and Their Meaning

Penetration Test. Determines the hardness or softness of the material. "Degrees penetration" means the distance (in 1/100 of a centimeter) a standard needle will penetrate into the asphalt when loaded from 50 to 200 grams, usually for 5 seconds, at a specified temperature. Soft asphalts show high penetration while harder materials give values as low as 10.

Temperature susceptibility (how the asphalt softens with changes in temperature) can be determined by making a series of penetrations at various temperatures. These have been arbitrarily set as follows:

Temperature F.	Loading, grams	Time, seconds
32	200	60
39.2	200	60
77	100	5
100	100	5
115	50	5

This test is empirical and was developed for materials such as asphalt. The Float Test for semi-fluid materials may be used for materials of over 300 penetration. Still softer products require the use of a viscosimeter. The penetration test is made according to A.S.T.M. procedure.

Softening Point shows the softening of the material. Melting point is inaccurate as asphalt shows no definite melting point. The test is made by filling a standard brass ring with molten asphalt, allowing the material to cool, placing a steel ball of definite weight upon the hard asphalt (at 41 F.) and raising the temperature at a rate of 9 degrees per minute until the ball has forced the softening asphalt to touch the bottom of the glass beaker. At that point the softening point is recorded.

This test, ordinarily not required for paving asphalts, does, along with the penetration test, give excellent information for calculating various ratios and susceptibility indices, etc. The average 60 penetration paving asphalt will have a softening point of 114-134 F. This test is most commonly used for grading roofing asphalts.

The penetration Index does not vary substantially with the penetration of asphalt from the same base stock or crude oil. It varies with the nature of the crude and the processing methods used as follows:

	Penetration Index
Panuco (Heavy Mexican crude oil)	0.0—0.5
Mene Grande (Heavy Venezuelan crude)	—0.6
Cracking coil asphalts	—2.0 of lower
Brown or oxidized asphalts (coating asphalts)	over 1.0

Ductility Test. Gives only a partial indication as to quality of asphalts. The material is pulled out in a standard sized mold (A.S.T.M. procedure), in a water bath at 77 F. and a rate of pull of 5 centimeters per minute. The distance the thread of asphalt can be pulled to just where it has broken is measured in centimeters.

Paving asphalts ranging from 50-150 penetration at 77 F. usually show a long ductility of over 150 centimeters. High ductility does not necessarily indicate quality. Asphalts from heavy, high asphalt base crudes, invariably show high ductilities at 77 F. Asphalts from mixed base crudes and oxidized asphalts may run lower in ductility. This test should be run on materials as near 50-60 penetration as possible.

Viscosity. Is not strictly a paving asphalt test but is included here to obtain fluidity constants for determining the proper application temperature. Furol Saybolt apparatus, Falling Ball apparatus, Fenske type capillary viscosimeter—are all commonly used for determining viscosity by A.S.T.M. procedure.

The sol type of asphalts will ordinarily show low viscosities at elevated temperatures (Susceptible asphalts), while asphalts of very heavy crude origin, will be less fluid, the blown roofing types being the highest in viscosities among the unblended oil asphalts.

Loss on Heating at 335 F. for 5 Hours. Shows the presence of light oils and often the presence of cracked products. Oil asphalts from very heavy crudes show practically no loss on heating when properly steam or vacuum reduced.

This test is used in some specifications for the heavier grades of road oils. The "fluxed" asphalts show greater loss on heating straight reduced material of equal penetration. The penetration test made after heating shows the hardening tendencies of the material, and this test is also part of modern paving asphalt specifications.

The test is conducted by heating 50 grams of the material in a standard seamless tin at a constant temperature of 325 F. for five hours. After cooling, the sample is weighed and may be remelted for the penetration test.

Specific Gravity. Is useful for calculating shipping weights of the asphalt and also gives some indication as to the origin of the asphalt. Specific gravity increases with decrease in penetration at 77 F. The higher the content of asphaltenes in the material, the larger is the specific gravity of the asphalt.

Part 6 will appear in an early issue.

Cost Comparisons by Capitalized Cost

Here's how to use the capitalized cost method without limitations for making cost comparisons.

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THE MOST SIGNIFICANT feature of modern industrialization is the high capitalization used in technology, and this is particularly true for the petroleum and allied industries. At all levels, from management to the maintenance engineer, survival demands the use of capital. But capital must be used on an economical basis. It is not enough that an expenditure eventually merely pays back the value of the expenditure. It must return itself and in addition yield a rate of return on the investment. Hence all exact engineering cost comparisons must include interest, the time value of money.

Here is an exact method for making cost comparisons based on capitalized cost. Interest has been considered for all the mathematical relationships offered.

If the facilities have different service lives it is necessary that the period chosen for the comparison be such that the facilities are compared on some basis which is a common denominator of their service lives. Infinity is a common denominator for all service lives and is the common denominator used in the capitalized cost method.

Capitalized cost can be defined as the present value of all costs (and receipts) for an indefinite time. The article having the lowest capitalized cost is the most economical.

Because capitalized cost is the present value of all costs it corrects for the difference in time at which costs may occur. This it does by converting all costs to a common instant, the present, using compound interest for transferring an amount from one time to another. Hence the capitalized cost method is fundamentally a present worth method.

Capitalized cost uses an indefinite time interval in computing the cost, that is it is the cost on a forever basis. This is done merely as a mathematical convenience to express all service lives on a common denominator basis. It should be clearly understood that "forever" is used only in this sense and that capitalized cost does not imply in any way whatsoever that a particular article will be replaced in kind forever. The example below shows that a comparison made by capitalized cost will be correct for a limited time period.

The purpose here is to demonstrate how to use capitalized cost. Derivations and mathematical analyses have been given elsewhere.[2,3]

It is convenient to have the values for certain numerical factors when making calculations by capitalized cost. These factors are

$$G_{m,i} = \frac{1}{(1+i)^m - 1} \quad (1)$$

$$I_{m,i} = (1+i)^m \quad (2)$$

where i is the interest rate, decimal per year, and m is a period of years.

Values of the G factor are given in Table 1. The I factor is merely the compound interest factor, values of which are given in Table 2.

A third factor, the F factor, need not be tabulated as it is related to the corresponding G factor by a simple relationship

$$F_{m,i} = \frac{(1+i)^m}{(1+i)^m - 1} = 1 + G_{m,i}. \quad (3)$$

The Simplest Case—If an article costs C and lasts m years the capitalized cost K is given by

$$K = CF_{m,i} = C\,(1 + G_{m,i}). \quad (4)$$

Example 1. Condenser tubes in a unit cost $10,000 and last two years. How much can be spent for tubes that last ten years if money is worth 8 percent per year?

Capitalized cost of the 2 year tubes by Equation 4 is

$$\begin{aligned} K &= 10{,}000\ F_{2,8\%} \\ &= (10{,}000)\ (7.010) \\ &= \$70{,}100. \end{aligned}$$

For equal economy the capitalized cost of the ten year tubes must not exceed this.

$$\begin{aligned} 70{,}100 &= CF_{10,8\%} \\ &= C\ (1.863) \\ C &= \$37{,}630 \end{aligned}$$

That is up to $37,630 could be spent for the ten year tubes.

It can be readily shown that the above result is not dependent upon actually replacing either set of tubes in kind forever. Consider that the end of ten years from now will be a good instant to compare the two alterna-

TABLE 1
Value of $G_{m,i}$
$G_{m,i} = 1/[(1+i)^m - 1]$
Use This Table Also for $F_{m,i} = 1 + G_{m,i}$

m	$G_{m,4}$	$G_{m,6}$	$G_{m,8}$	$G_{m,10}$	$G_{m,12}$	$G_{m,15}$	$G_{m,20}$	$G_{m,25}$	$G_{m,30}$	$G_{m,40}$	$G_{m,50}$
1	25.00	16.67	12.50	10.00	8.333	6.667	5.000	4.000	3.333	2.500	2.000
2	12.25	8.091	6.010	4.762	3.931	3.101	2.273	1.778	1.449	1.042	0.8000
3	8.006	5.235	3.851	3.021	2.470	1.920	1.374	1.049	0.8354	0.5734	0.4211
4	5.887	3.810	2.774	2.155	1.744	1.335	0.9314	0.6937	0.5388	0.3519	0.2462
5	4.616	2.957	2.131	1.638	1.312	0.9888	0.6719	0.4874	0.3686	0.2284	0.1517
6	3.769	2.389	1.704	1.296	1.027	0.7616	0.5035	0.3553	0.2613	0.1532	0.09924
7	3.165	1.986	1.401	1.054	0.8260	0.6024	0.3871	0.2654	0.1896	0.1048	0.06217
8	2.713	1.684	1.175	0.8744	0.6775	0.4857	0.3030	0.2016	0.1397	0.07268	0.04060
9	2.362	1.450	1.001	0.7364	0.5640	0.3972	0.2404	0.1550	0.1041	0.05086	0.02671
10	2.082	1.264	0.8629	0.6275	0.4749	0.3283	0.1926	0.1203	0.07821	0.03581	0.01765
15	1.249	0.7160	0.4604	0.3147	0.2235	0.1401	0.06925	0.03647	0.01993	0.006470	0.002289
20	0.8396	0.4531	0.2732	0.1746	0.1157	0.06507	0.02678	0.01166	0.005289	0.001197	0.0003006
25	0.6003	0.3038	0.1710	0.1017	0.06250	0.03133	0.01059	0.003792	0.001419	0.0002223	0.00003960

tives because at that time, whichever plan had been chosen, we will have a set of worn out tubes.

The accumulated value of the money spent for the purchase of five sets of two year tubes referred to ten years from now will be

$$10{,}000\ (1.08)^{10} + 10{,}000\ (1.08)^{8} + 10{,}000\ (1.08)^{6} + 10{,}000\ (1.08)^{4} + 10{,}000\ (1.08)^{2} = \$81{,}240.$$

The value of the money spent for a single set of tubes costing $37,630 and lasting ten years referred to ten years from now will be

$$37{,}630\ (1.08)^{10} = \$81{,}240.$$

Both alternatives have the same cost when judged by the equivalent cumulative cost as of ten years from now. This makes it evident that although capitalized cost itself is calculated on a perpetual basis, cost comparisons made from it are correct for a limited time period.

Example 2. Condenser tubes cost $10,000 and last two years. If money is worth 8 percent per year how long would tubes costing $25,000 have to last to be equally economical?

Capitalized cost of the two year tubes is $70,100 from Example 1. Then for equal economy for the $25,000 tubes

$$70{,}100 = 25{,}000\ (1 + G_{m,8\%})$$
$$G_{m,8\%} = 1.804.$$

From Table 1

$$G_{2,8\%} = 2.131$$
$$G_{6,8\%} = 1.704.$$

By interpolation the $25,000 tubes would have to last about 5.8 years.

Example 3. A tank costs $10,000 and lasts ten years. If money is worth 8 percent per year, how much can be spent now to patch up an old worn out tank so as to get another year's life?

Capitalized cost of the ten year tank by Equation 4 is

$$K = 10{,}000\ F_{10,8\%}$$
$$= 10{,}000\ (1.863)$$
$$= \$18{,}630.$$

Capitalized cost of the patching job basis one year's service must not exceed this.

$$18{,}630 = CF_{1,8\%}$$
$$= C\ (13.50)$$
$$C = \$1{,}380$$

That is, up to $1,380 could be spent for the repair job.

Example 3 is similar to Example 1 and is included only to emphasize the similarity of mathematical treat-

TABLE 2
Value of $I_{m,i}$
$I_{m,i} = (1+i)^m$

m	$I_{m,4}$	$I_{m,6}$	$I_{m,8}$	$I_{m,10}$	$I_{m,12}$	$I_{m,15}$	$I_{m,20}$	$I_{m,25}$	$I_{m,30}$	$I_{m,40}$	$I_{m,50}$
1	1.040	1.060	1.080	1.100	1.120	1.150	1.200	1.250	1.300	1.400	1.500
2	1.082	1.124	1.166	1.210	1.254	1.323	1.440	1.563	1.690	1.960	2.250
3	1.125	1.191	1.260	1.331	1.405	1.521	1.728	1.953	2.197	2.744	3.375
4	1.170	1.263	1.361	1.464	1.574	1.749	2.074	2.441	2.856	3.842	5.063
5	1.217	1.338	1.469	1.611	1.762	2.011	2.488	3.052	3.713	5.378	7.594
6	1.265	1.419	1.587	1.772	1.974	2.313	2.986	3.815	4.827	7.530	11.39
7	1.316	1.504	1.714	1.949	2.211	2.660	3.583	4.768	6.275	10.54	17.09
8	1.387	1.594	1.851	2.144	2.476	3.059	4.300	5.961	8.157	14.76	25.63
9	1.423	1.690	1.999	2.358	2.773	3.518	5.160	7.451	10.61	20.66	38.44
10	1.480	1.791	2.159	2.594	3.106	4.046	6.192	9.313	13.79	28.93	57.67
15	1.801	2.397	3.172	4.177	5.474	8.137	15.41	28.42	51.19	155.6	437.9
20	2.191	3.207	4.661	6.728	9.646	16.37	38.34	86.74	190.1	836.7	3,325.
25	2.666	4.292	6.849	10.84	17.00	32.92	95.40	264.7	705.7	4,500.	25,250.

ment for various problems. In Example 3 one alternative is to patch an old tank to last one year more, but this is only worth what we can afford for a new tank which lasts one year.

Example 4. Condenser tubes cost $10,000 and last three years. What is the maximum rate of return which will justify purchasing tubes that cost $25,000 and last ten years?

Problems for determination of the rate of return require a trial and error method of solution. Capitalized costs of the three and ten year tubes are respectively

$$K_{(3)} = 10{,}000\ F_{3,i}$$
$$K_{(10)} = 25{,}000\ F_{10,i}$$

which for i = 8 percent become

$$K_{(3)} = 10{,}000\ (4.851) = \$48{,}510$$
$$K_{(10)} = 25{,}000\ (1.863) = \$46{,}580.$$

Thus at 8 percent rate of return the ten year tubes are the more economical.

For i = 10 percent the capitalized costs are

$$K_{(3)} = 10{,}000\ (4.021) = \$40{,}210$$
$$K_{(10)} = 25{,}000\ (1.628) = \$40{,}700.$$

At 10 percent rate of return the three year tubes are the more economical. By interpolation the capitalized costs become equal at i = 9.6 percent. At any rate of return less than 9.6 percent the ten year tubes are the more economical. At any rate of return greater than 9.6 percent the three year tubes are the more economical.

The example above illustrates that the comparison is dependent upon the rate of return used in the calculation. A decision made at one rate of return may be reversed at another rate of return. This is not peculiar to capitalized cost and is the situation for any method involving the consideration of interest. Generally speaking, a low rate of interest favors high cost long lasting articles whereas a high rate of interest works against them, as illustrated in the preceding example.

Uniform Yearly Expense—The capitalized cost of a yearly expense M, such as a maintenance cost, is

$$K = MF_{\infty,i} = M\ (1 + G_{\infty,i}). \qquad (5)$$

Equation (5) can also be written

$$K = M\left(\frac{1+i}{i}\right). \qquad (6)$$

Equations (5) and (6) can only be used when M is constant from year to year and occurs every year.

It is true that a maintenance expense would probably occur throughout the year whereas in Equations (5) and (6) M is the single equivalent cost as of the beginning of the year. For any practical problem this treatment is accurate enough. Unless continuously compounded interest is used any expense must be treated by its equivalent value as of the beginning of the year, or the end of the year, inasmuch as a year is the smallest time interval considered in this presentation.

On the other hand if the yearly expense is meant to be the equivalent expense as of the end of the year the relationships corresponding to Equations (5) and (6) are

$$K = M'G_{1,i} \qquad (7)$$

or

$$K = \frac{M'}{i} \qquad (8)$$

where M′ is a uniform yearly expense referred to the end of the year.

Example 5. A supporting structure used in an acid atmosphere costs $10,000 and lasts five years. If money is worth 8 percent per year, how much can be spent uniformly at the beginning of each year so as to obtain ten years service?

Capitalized cost basis five year's life is by Equation (4).

$$K = CF_{5,8\%} = (10{,}000)\ (3.131) = \$31{,}310.$$

For equal economy the capitalized cost basis 10 year's life must be the same, and is obtained by combining Equations (4) and (5).

$$31{,}310 = 10{,}000\ F_{10,8\%} + MF_{\infty,8\%}$$
$$= 10{,}000\ (1.863) + M\ (13.50)$$
$$M = \$939.$$

That is, up to $939 could be spent at the beginning of each year for the ten years.

Irregular Yearly Expense—If the yearly expense is irregular Equations (5), (6), (7), and (8) are unsuitable. However, if an article or system lasting m years incurs an expense B_x at the beginning of the xth year, the capitalized cost of the single expense B_x is

$$K = \frac{B_x}{I_{(x-1),i}} F_{m,i} = \frac{B_x}{I_{(x-1),i}} (1 + G_{m,i}) \qquad (9)$$

or in terms of a single expense B'_x occurring at the end of the xth year

$$K = \frac{B'_x}{I_{x,i}} F_{m,i} = \frac{B'_x}{I_{x,i}} (1 + G_{m,i}). \qquad (10)$$

By summing for all the years Equations (9) and (10) can be used to calculate the capitalized cost regardless of how irregular the yearly expenses may be.

Salvage Value—If an article lasts m years and has a salvage value L at the end of m years, capitalized cost of the salvage value is

$$K = -LG_{m,i} \qquad (11)$$

where the negative sign denotes that salvage value is a receipt.

Non-Depreciable Cost—If a cost is such that it can be recovered in full at all times, such as the cost of land for a venture, the capitalized cost is given by

$$K = N \qquad (12)$$

where N is a non-depreciable cost. Working capital can be regarded as belonging in this category also.

An Extensive Example—The following example shows how various different types of costs are treated in one problem.

Example 6. A heat exchanger uses steel tubes which cost $10,000 and last four years with $2000 salvage value. Cost for cleaning the inside of the tubes is $3000 per year referred to the beginning of the year. At the beginning of the third year the outside of the tubes must be cleaned at a cost of $4000, and at the beginning of the fourth year there is an extra maintenance expense of $1500. It is proposed to substitute alloyed tubes costing $95,000

which last ten years with $20,000 salvage value. Maintenance for the alloyed tubes is $1000 per year and savings from increased production $6000 per year, or a net of —$5000 per year referred to the beginning of the year. If money is worth 8 percent per year, does it pay to install the alloy tubes?

Capitalized cost of the steel tubes by Equations (4), (11), (5), and (9) twice, in order is

$$CF_{4,8\%} = (10{,}000)\ (3.774) = 37{,}740$$
$$-LG_{4,8\%} = -(2000)\ (2.774) = -5{,}550$$
$$MF_{1,8\%} = (3000)\ (13.5) = 40{,}500$$
$$\frac{B_2}{I_2} F_{4,8\%} = \frac{4000}{1.1664}\ (3.774) = 12{,}940$$
$$\frac{B_4}{I_4} F_{4,8\%} = \frac{1500}{1.2597}\ (3.774) = 4{,}490$$
$$K = \$90{,}120$$

Capitalized cost of the alloyed tubes by Equations (4), (11), and (5), in order is

$$CF_{20,8\%} = (95{,}000)\ (1.8629) = 176{,}980$$
$$-LG_{20,8\%} = -(20{,}000)\ (0.8629) = -17{,}260$$
$$MF_{1,8\%} = -(5000)\ (13.5) = -67{,}500$$
$$K = \$92{,}220.$$

Capitalized cost of the steel tubes is $90,120 against $92,220 for the alloyed tubes, hence it will not pay to substitute the latter with i = 8 percent.

Replacement of an Existing Facility—Frequently an old facility, although it is still serviceable to some degree, can be replaced by a modern facility before the old facility is completely worn out. Such problems can be worked out on a capitalized cost basis. It is merely necessary to calculate the capitalized cost of continuing with the old facility and compare this with the capitalized cost of the new facility.

Generally the analysis for the old facility (Existent) can be limited to one year ahead. This is because operating costs and other disadvantages of the Existent, in most cases, grow more unfavorable as time progresses so in the next year ahead the Existent will make its most favorable impression.

When we decide to keep the Existent one more year we forego its present net realizable salvage value L_o. This value is simply its value in today's market. It is not the Existent's undepreciated book value, or even what it is worth to operations.

Capitalized cost of foregoing present salvage value on a one-year basis is

$$K = L_o F_{1,i} = L_o\ (1 + G_{1,i}). \qquad (13)$$

Credited to our capitalized cost is the salvage value L_1 of the Existent one year hence, or

$$K = -L_1 G_{1,i}. \qquad (14)$$

If all expenses of the Existent for the next year are referred to the beginning of the year (M) their capitalized cost is

$$K = MF_{1,i} = M\ (1 + G_{1,i}). \qquad (15)$$

Capitalized cost of the Existent on a one year basis is simply the sum of Equations (13), (14), and (15). Capitalized cost of the Replacement is calculated from the equations already given.

Example 7. An old motor can be sold for $200. If used another year it will bring $150. It will cost $300 to recondition the motor for another year's use. A new motor can be purchased for $5000, will last 20 years, and have a salvage value of $300. It will save $300 per year in power compared to the existing motor and have a yearly maintenance cost of $50, both figures referred to the beginning of the year. If money is worth 8 percent, does it pay to install the new motor now?

Capitalized cost of the Existent basis one year's service is

$$L_o F_{1,8\%} = (200)\ (13.5) = 2{,}700$$
$$-L_1 G_{1,8\%} = -(150)\ (12.5) = -1{,}875$$
$$MF_{1,8\%} = (300)\ (13.5) = 4{,}050$$
$$K = \$4{,}875$$

Capitalized cost of the Replacement basis 20 year's service by use of Equations (4), (11), and (5), in order is

$$CF_{20,8\%} = (5{,}000)\ (1.273) = 6{,}365$$
$$-LG_{20,8\%} = -(300)\ (0.2732) = -82$$
$$MF_{1,8\%} = (50\text{-}300)\ (13.5) = -3{,}375$$
$$K = \$2{,}908.$$

Comparing capitalized cost of Replacement with cost of Existent, it will pay to install the new motor now.

There are circumstances when the Existent must be considered on more than a one year basis. Such cases where the capitalized cost for more than one year's service are less than for just one more year's service are usually evident from inspection. In practice they arise principally from two causes:

- Net realizable salvage value may decline sharply for the first year;
- Benefits of an overhaul may extend more than one year.

If more than one year's service must be considered, calculation of the capitalized cost of the Existent introduces nothing new, but it must be made by the method given for the Replacement.

Example 8. A tank with negligible salvage value now or later can be repaired for $3,000 to extend its life one year, after which $1,000 per year will extend the life two more years. A new tank costs $15,000, lasts ten years with negligible salvage value and has no annual expense. If money is worth 8 percent, should replacement be made now?

Capitalized cost of Existent, 1 year's service:

$$MF_{1,8\%} = (3{,}000)\ (13.5) = \$40{,}500.$$

Capitalized cost of Existent, 3 year's service:

$$CF_{2,8\%} = (3{,}000)\ (4{,}851) = 14{,}550$$
$$\frac{B_2}{I_{1,8\%}} F_{2,8\%} = \frac{1{,}000}{1.08}\ (4{,}851) = 4{,}490$$
$$\frac{B_2}{I_{2,8\%}} F_{2,8\%} = \frac{1{,}000}{1.1664}\ (4{,}851) = 4{,}160$$
$$K = \$23{,}200$$

Capitalized cost of Replacement, 10 year's service:

$$CF_{10,8\%} = (15{,}000)\ (1.863) \qquad = \$27{,}950.$$

Based on one year more service the Existent compares unfavorably with the Replacement, $40,500 against $27,950. Based on three years more service the Existent is more economical, $23,200 against $27,950. In this example it is evident on inspection that if the Existent is to be continued at all a three-year period is more favorable than a one-year period.

Alternative Expression of Results—Although capitalized cost is a valuable tool for making cost comparisons the results can be expressed in other terms if recommendations are being made to management and others.

The analysis can be presented on the basis of pay-out time as in Example 2, and this basis of comparison has wide usage. Pay-out time has a different meaning to different authors, but pay-out time as determined in Example 2 includes interest on the investment. For many problems in maintenance work requiring the choice of one material over another, such as for condenser tubes, the calculation for pay-out time requires only a knowledge of the relative costs of the materials. This permits making a decision even when the exact costs are not readily available. If the service life of one of the materials is not known the problem can be worked backwards with a calculation of how long it would have to last. If the service life can be expected to exceed the calculated pay-out time the material is justified. This will help in making a decision when the exact service life is not known.

The results can also be expressed on the basis of rate of return realized as in Example 4. Usually this involves a tedious trial and error calculation. The rate of return method is useful for an entire venture when comparing expenditures against receipts. A high rate of return is indicative of a short pay-out time. However, the shorter the pay-out time the less effect interest has, so the simpler calculation for pay-out time in such cases will reveal as much as a calculation of the rate of return even though the pay-out time has been calculated at a different rate of return. The calculation for rate of return in Example 4 means simply that the ten year tubes are justified at any rate of return up to 9.6 percent.

For problems involving an entire venture where the rate of return is a satisfactory criterion, capitalized cost can be used. This is indicated in the closing paragraphs.

The results can also be expressed in terms of a yearly cost by means of the following simple relationship

$$k = iK, \qquad (16)$$

where k is the equivalent uniform yearly cost referred to the end of the year.

For example if Plan A has a capitalized cost of $1,000,000 and Plan B $1,200,000 and money is worth 8 percent per year, then the difference in the two plans can be stated as

$$\Delta K = 1{,}200{,}000 - 1{,}000{,}000 = \$200{,}000$$
$$i\,(\Delta K) = (.08)\ (200{,}000) \quad = \$16{,}000.$$

That is, Plan A is cheaper on a capitalized cost basis by $200,000, if money is worth 8 percent per year. Also on a yearly basis it is cheaper by $16,000 per year referred to the end of each year, if money is worth 8 percent per year.

Effect of Income Tax—Calculations based on capitalized cost can be extended to include the effect of income tax.

Generally speaking, the effect of income tax is to add disfavor to a higher cost longer lasting article. Income tax has the same general effect as increasing the rate of return in a calculation without considering taxes. Table 3 should make this clear.

TABLE 3
Equivalent Cost For Articles, $
(Sum-of-the-digits Depreciation)

	I	II
Rate of return used in calculation, percent	8	8
Tax rate, percent	0	52
Price of an article lasting one year	10,000	10,000
Permissible price for an article lasting 10 years	72,460	61,470

If there is no income tax and the calculation is made on the basis of an 8 percent rate of return by equations already given, it will be found that $72,460 is justified for an article lasting ten years if a $10,000 article lasts one year. On the other hand, by using equations to be given below it will be found that if the rate of return is 8 percent after taxes, and with an income tax rate of 52 percent, only $61,470 would be justified for the ten year article.

To obtain the amount $61,470 in the column headed I, Table 3, (as opposed to $72,460) it would be necessary to use some rate of return higher than 8 percent.

Generally speaking, many cost comparisons are made using a high rate of return in the calculations; and in a sense are already compensating for the income tax consideration, although usually the high rate of return is used to compensate for risk and to insure that only outstanding investments are made.

There are cases, however, where income tax must be considered on an exact basis. A detailed analysis has already been published[3] and only the results are discussed here.

Taxes and Rate of Return—One effect introduced by income tax is a reduction in the return on investment. If i is the rate of return before taxes, t the income tax rate, and r is the return on investment after taxes, all expressed as a decimal per year, then

$$r = i\,(1 - t). \qquad (17)$$

When income tax is considered it is more convenient to express the relationships for capitalized cost in terms of r.

Depreciation—The capitalized cost method can be applied to any method of depreciation used for income tax purposes but for purposes of illustration in this article sum-of-the-digits depreciation is used.

The ψ factor, which is associated with depreciation, is given by

$$\psi_{m,r} = \sum_{x=1}^{x=m} \frac{D_x}{(1+r)^x} \qquad (18)$$

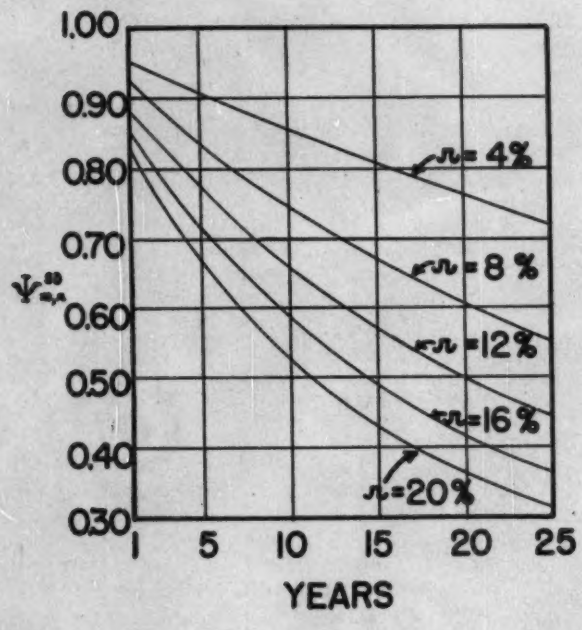


FIGURE 1—A plot of ψ values for sum-of-the-digits depreciation for various rates and values of m up to 25 years.

where D_x is the depreciation, expressed as a decimal, for the end of the xth year. The ψ factor is the present value of the decimal depreciation. It can be calculated for any method of depreciation. Figure 1 is a plot of its value for sum-of-the-digits depreciation for various rate of returns and values of m up to 25 years. The superscript SD in the factor is used to specifically denote sum-of-the-digits depreciation. The equations which follow are valid for any method of depreciation, but the numerical results will depend slightly upon the method used for depreciation.

Income taxes are considered to be paid in one sum at the end of the year, which assumption is adequate for the purpose.

Initial Cost—The capitalized cost with income taxes included, K_t, for an article having a depreciable first cost C_d and lasting m years is given by the relationship

$$K_t = C_d F_{m,r} (1 - t\psi_{m,r}). \qquad (19)$$

Here C_d is the depreciable part of the first cost and is the first cost minus the salvage value (C — L).

Equation (19) is given in a form suitable for any tax rate. For a given rate and method for taking depreciation the value of the term in parentheses on the right reduces to a value which like $F_{m,r}$ depends only on the values for m and r. In using Equation (19), with taxes, as opposed to Equation (4), without taxes, the only extra work involved is multiplication by an additional term. This is generally true for all the equations in which the tax situation has been included. Accordingly calculations based on inclusion of the income tax are equally direct and require no new techniques.

The value of m used in the F and ψ factors of Equation (19) need not be the same. For example if a venture lasting ten years is permitted to be written off in five years for tax purposes, then use m = 10 for the F factor and m = 5 for the ψ factor.

Example 9. Recalculate Example 1 with an income tax rate of 52 percent and money worth 8 percent after taxes.

By Equation (19) K_t for the 2 year tubes is

$$\begin{aligned} K_t &= (10{,}000)\ (F_{2,8\%})\ (1 - 0.52\ \psi_{2,8\%}) \\ &= (10{,}000)\ (7.010)\ (1 - (0.52)\ (0.9035)) \\ &= \$37{,}170. \end{aligned}$$

For the same K_t for the 10 year tubes

$$\begin{aligned} 37{,}170 &= C_d F_{10,8\%}\ (1 - 0.52\ \psi_{10,8\%}) \\ &= C_d\ (1.863)\ (1 - (0.52)\ (0.7477)) \\ C_d &= \$32{,}640. \end{aligned}$$

That is, with the tax situation included, up to $32,640 can be spent for the ten year tubes.

Other Costs—For a uniform yearly expense M referred to the beginning of the year, occurring every year, and written off in one year for tax purposes

$$K_t = MF_{1,r}\ (1 - t\ \psi_{1,r}). \qquad (20)$$

If an article lasts m years and incurs an expense B_x at the beginning of the xth year, which can be fully depreciated in one year, capitalized cost of the single expense B_x is

$$K_t = \frac{B_x F_{m,r}}{I_{(x-1),r}} (1 - t\psi_{1,r}). \qquad (21)$$

Capitalized cost of salvage value L, the non-depreciable part of the first cost, for an article lasting m years is

$$K_t = +L \qquad (22)$$

where the positive sign is correct for this purpose.

Capitalized cost of a non-depreciable cost N, such as land or working capital, is

$$K_t = N. \qquad (23)$$

An Extensive Example—**Example 10.** Recalculate Example 6 on the basis of a 52 percent tax rate money being worth 8 percent per year after taxes.

Capitalized cost of the steel tubes is obtained from Equations (19), (22), (20), and (21) twice, in order.

$$\begin{aligned} &(10{,}000 - 2{,}000)\ F_{4,8\%}\ (1 - 0.52\ \psi_{4,8\%}) = \\ &\quad (8{,}000)\ (3.744)\ (0.5529) && = 16{,}693 \\ &(2{,}000)\ (1) && = 2{,}000 \\ &(3{,}000)\ F_{1,8\%}\ (1 - 0.52\ \psi_{1,8}) = \\ &\quad (3{,}000)\ (13.5)\ (0.5185) && = 21{,}000 \\ &4{,}000\ \frac{F_{4,8\%}}{I_{2,8\%}} (1 - 0.52\ \psi_{2,8\%}) = \\ &\quad (4{,}000)\left(\frac{3.774}{1.1664}\right)(0.5185) \\ &1{,}500\ \frac{F_{4,8\%}}{I_{2,8\%}}\ (1 - 0.52\ \psi_{2,8\%}) = \\ &\quad (1{,}500)\left(\frac{3.774}{1.2597}\right)(0.5185) && = 2{,}330 \\ & && K_t = \$48{,}734 \end{aligned}$$

Capitalized cost of the alloy tubes is obtained from Equations (19), (22), and (20), in order.

$$(95{,}000 - 20{,}000)\, F_{20,8\%}\, (1 - 0.52\, \psi_{20,8\%}) = (75{,}000)\,(1.863)\,(0.6112) = 85{,}400$$

$$(20{,}000)\,(1) = 20{,}000$$

$$-(5{,}000)\, F_{5,8\%}\, (1 - 0.52\, \psi_{5,8\%}) = -(5{,}000)\,(13.5)\,(0.5185) = -35{,}000$$

$$K_t = \$70{,}400$$

It will not pay to substitute the alloy tubes, capitalized cost of $70,400 against $48,734 for the steel tubes.

It is interesting to note the comparative costs between Example 6, no taxes, and Example 10, with taxes. The ratio of capitalized costs of the ten year tubes compared to the four year tubes is

$$\frac{92{,}220}{90{,}120} = 1.02 \qquad \text{(Example 6)}$$

$$\frac{70{,}400}{48{,}734} = 1.44 \qquad \text{(Example 10)}.$$

Both Examples were calculated using the same net rate of return, 8 percent. The inclusion of income taxes in Example 10 makes the ten year tubes even less favorable, in agreement with the previous discussion.

Equivalent Yearly Cost With Taxes—Corresponding to Equation (16) the following relation is valid

$$k_t = rK_t \qquad (24)$$

where k_t is the equivalent uniform yearly cost, with taxes considered, referred to the end of the year.

No Limitations—Capitalized cost is a valuable tool for making cost comparisons in selecting alternatives. The method is exact as it allows for interest, the time value of money. It has no limitations and any conceivable type of cost or receipt can be incorporated in the calculation. For the most part it requires only the repeated use of a relatively few relationships, and the calculations are readily made with the help of a few tabulated factors.

For purpose of presentation the Examples given in the article apply to simple cases. However, more extensive problems are basically no different and merely require more calculations of the same general type.

Entire Venture—By combining suitable equations capitalized cost can be applied to an entire venture to determine if the receipts over a period of years justify the venture. Thus we have

$$K_t = C_d F_{m,r}\, (1 - t\psi_{m,r}) + F_{m,r}\, (1 - t\,\psi_{1,r}) \sum_{x=1}^{x=m} \frac{B_x}{I_{(x-1),r}} + N + L. \qquad (25)$$

Here C_d is the depreciable initial cost of the facility lasting m years. B_x is the net yearly expense, before taxes and depreciation, referred to the beginning of the xth year. B_x for most years must be negative, a net income, if the project is to pay off. L is salvage value, and N represents the cost for non-depreciable first costs such as land and working capital.

If K_t is negative then the project pays off at a rate better than r. If K_t is positive the venture will not pay off at the rate r, but is not necessarily a loser.

If Equation (25) is solved for that value of r which makes $K_t = 0$, then r is the rate of return after taxes for the venture.

Happel[1] has derived a relationship similar to Equation (25) although his equation is based on present worth, not capitalized cost. Also his equation is in terms of B'_x, the yearly cost referred to the end of the year. He considers a receipt positive whereas in this presentation an expenditure is considered positive. His treatment of salvage value is slightly different with regard to the tax situation.

LITERATURE CITED

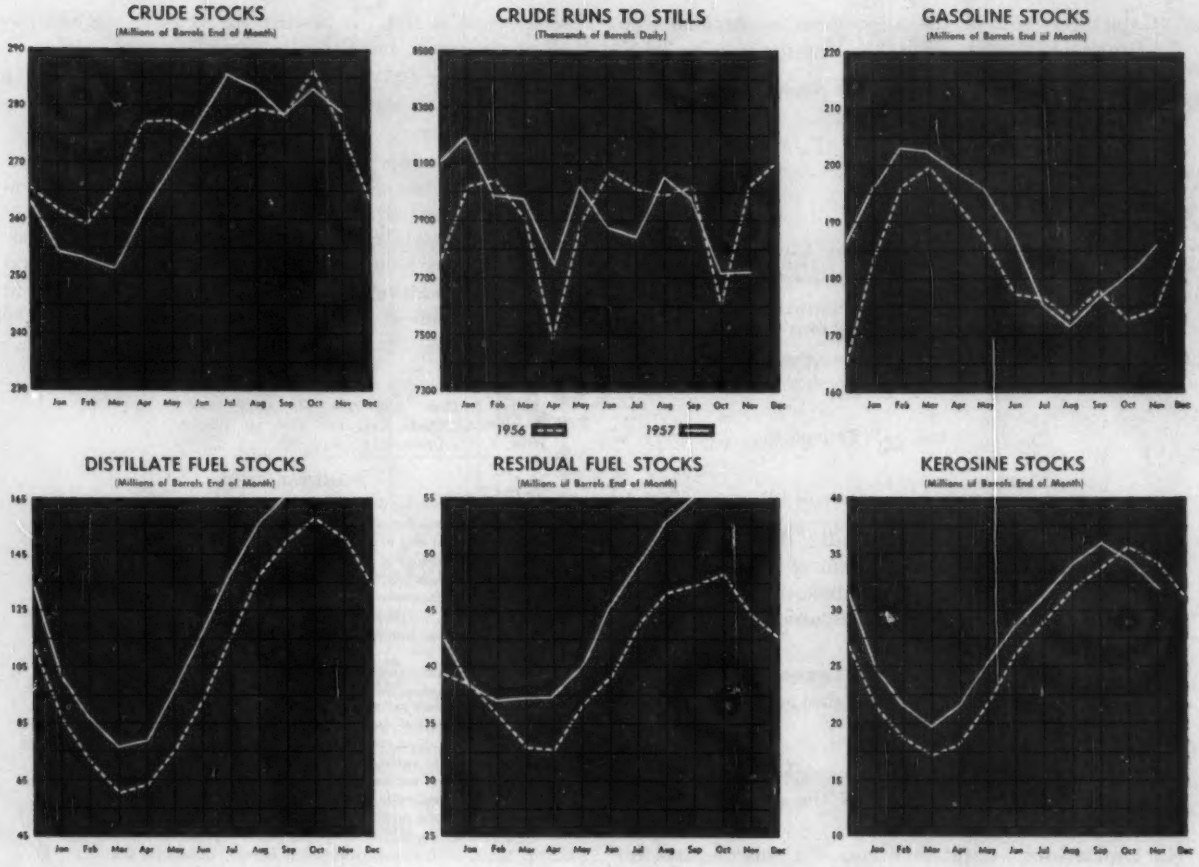
[1] Happel, J., Chem. Eng. Prog., 51, 533-539 (1955).
[2] Jelen, F. C., Chem. Eng., Feb. 1954, pp. 199-203.
[3] Jelen, F. C., Chem. Eng., Sept. 1957, pp. 271-275.

NOMENCLATURE

B_x	Expense for xth year, beginning of year, dollars.
B'_x	Expense for xth year, end of year, dollars.
C	Initial cost of a facility, dollars.
C_d	Initial cost of a facility minus salvage value, dollars.
D_x	Depreciation for xth year, decimal.
$F_{m,i}$	$1 + G_{m,i}$
$G_{m,i}$	$1/[(1 + i)^m - 1]$
i	Interest rate, decimal per year.
$I_{m,i}$	$(1 + i)^m$
k	Equivalent uniform end-of-year yearly cost, dollars per year.
k_t	Equivalent uniform end-of-year yearly cost after taxes, dollars per year.
K	Capitalized cost, dollars.
K_t	Capitalized cost after taxes, dollars.
L	Salvage value, dollars.
L_0	Present net realizable salvage value, dollars.
L_1	Net realizable salvage value, one year hence, dollars.
m	Life of a facility, years.
M	Uniform beginning-of-year yearly expense, dollars per year.
M'	Uniform end-of-year yearly expense, dollars per year.
N	Non-depreciable expense, dollars.
r	Rate of return after taxes, decimal per year.
t	Income tax rate, decimal.
x	The xth year.
$\psi_{m,r}$	A factor associated with depreciation.
SD	Sum-of-the-digits method of depreciation.

About the Author

F. C. JELEN, corrosion engineer in charge of corrosion control at Solvay Process division Allied Chemical and Dye Corporation is a licensed professional engineer in New York and has had over twenty years experience in heavy chemical industries. Jelen received his B.S. and M.S. degrees from Massachusetts Institute of Technology and his Ph.D. from Harvard graduate school of Arts and Sciences. He has combined his hobbies of boating and radio with a radio transmitter in the U.S. Coast Guard auxiliary where he is currently serving as Flotilla Commander.



Taking Stock

Cecil W. Smith
Economics Editor

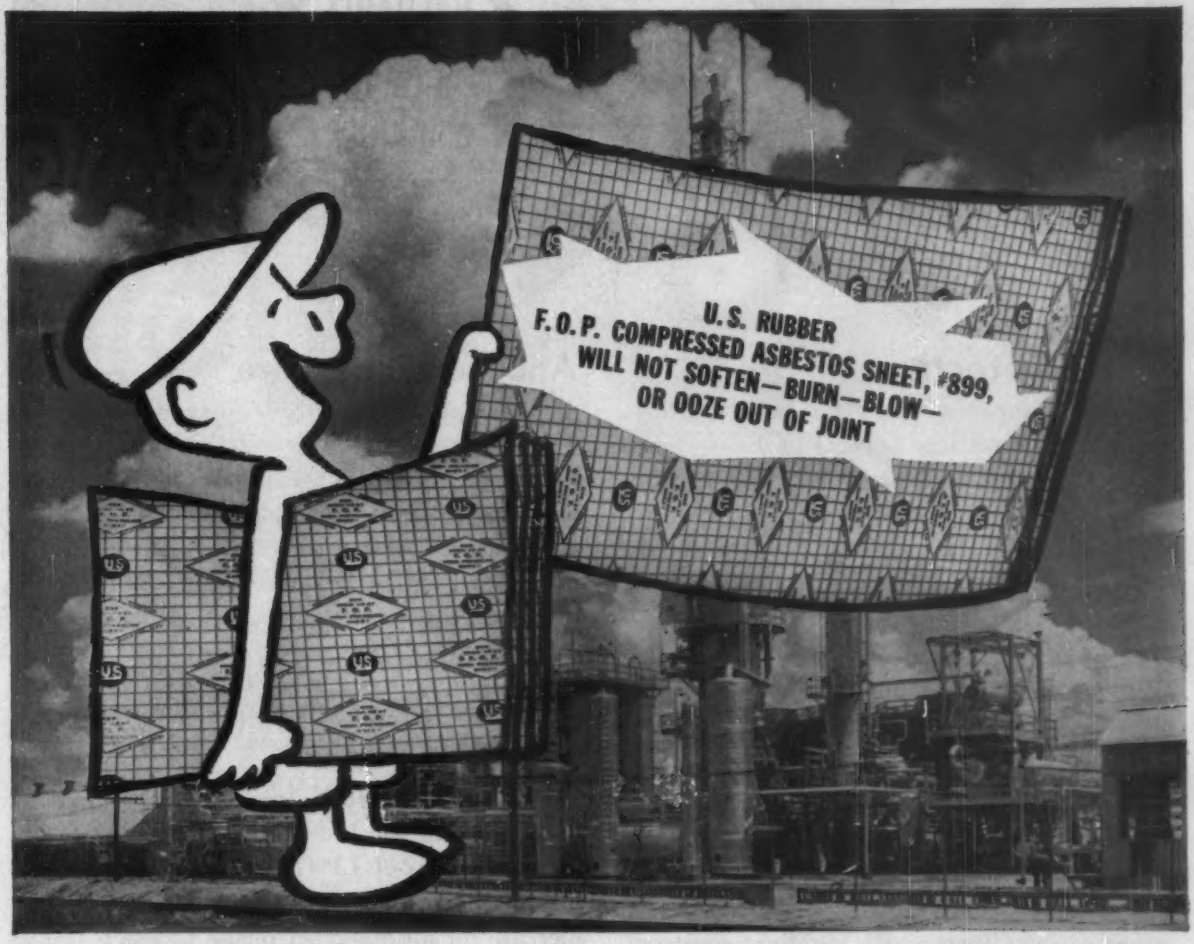
- Refinery runs hold at 1957 low
- Fuel oil stocks start to drop
- Oil imports take sharp decline

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1955:													
October	6,837	7,465	267,346	3,827	153,103	309	36,705	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	341	33,283	1,680	141,808	1,214	44,071	823	1,322
December	7,155	7,762	265,610	3,916	165,433	395	26,770	1,765	111,333	1,286	39,174	884	1,502
1956:													
January	7,199	8,023	261,592	3,927	183,905	385	21,310	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	385	18,712	1,918	71,335	1,286	35,673	878	1,472
March	7,278	7,914	265,683	3,829	199,698	342	17,215	1,808	60,846	1,213	32,984	934	1,425
April	7,146	7,487	277,121	3,646	193,299	299	18,227	1,713	63,571	1,130	32,740	815	1,305
May	7,064	7,896	277,497	3,859	186,673	292	21,883	1,667	75,928	1,149	36,607	938	1,416
June	7,100	8,071	274,491	3,976	177,076	290	26,111	1,755	93,758	1,098	39,073	987	1,426
July	7,090	8,014	277,008	3,975	176,536	296	28,990	1,767	115,787	1,066	43,958	1,084	1,463
August	7,195	7,995	279,944	4,037	172,939	313	31,826	1,839	137,905	1,091	46,617	1,001	1,399
September	7,054	8,024	278,791	3,991	177,974	329	33,588	1,845	150,411	1,062	47,342	1,043	1,452
October	6,966	7,608	286,560	3,773	172,798	356	35,667	1,772	158,871	1,082	48,400	1,004	1,541
November	7,139	8,031	275,995	3,913	174,808	384	34,329	1,841	151,517	1,182	44,590	871	1,362
December	7,377	8,141	266,014	4,039	187,271	379	31,420	1,981	133,981	1,288	44,491	873	1,471
1957:													
January	7,480	8,274	256,669	3,991	197,702	367	24,019	2,118	100,572	1,322	38,403	805	1,425
February	7,682	8,088	256,344	3,864	205,270	353	21,013	2,035	85,105	1,270	31,201	780	1,430
March	7,717	8,047	254,911	3,826	206,716	332	20,223	1,861	76,245	1,205	37,371	836	1,464
April	7,541	7,740	265,796	3,770	201,407	284	21,512	1,764	78,743	1,132	37,429	906	1,542
May	7,442	7,992	275,963	3,900	195,094	272	25,545	1,789	98,135	1,103	41,125	1,042	1,558
June	7,107	7,867	284,312	3,984	190,063	254	28,872	1,773	117,364	1,101	45,572	1,147	1,606
July	6,873	7,852	288,241	3,887	177,868	249	31,713	1,750	138,359	1,090	49,621	1,220	1,654
August	6,786	8,092	283,388	4,122	174,031	252	34,576	1,806	159,124	1,089	52,645	1,257	1,695
September	6,887	7,920	280,469	4,099	180,688	276	36,382	1,772	173,269	1,100	58,727	1,042	1,445
October	6,745	7,715	283,011	3,659	181,410	267	34,264	1,741	174,772	1,047	59,343	1,009	1,472
November	6,824	7,717	279,725	3,830	186,027	300	32,267	1,744	166,323	1,066	58,816	892	1,387
Week Ended:													
12-20-57	6,915	7,712	277,722	3,895	189,488	348	27,719	1,872	152,383	1,083	57,674	921	1,443
12-21-56	7,376	8,061	269,922	4,003	180,543	371	32,029	1,992	134,819	1,265	42,577	612	1,310

Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.

US PACKING

HOT NEWS for Hot Joints and Flanges



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Some companies paint for beauty, others paint for protection. Several of Esso's refining units are painted strictly to detect "hot spots" on reactor shells. You'll see a picture of the results of this type of test plus a description of how it works when you read this month's "How To Do It."

Keep Going to Page 209

More Polyethylene

That's the story now that Grace Chemical's new polyethylene plant has gone on stream at Baton Rouge, and you'll read all about the new plant in this month's "Who's Building" section. There are also dozens of other capsule items which highlight construction projects all over the world, including the latest word on a new refinery to be built on the Bataan peninsula. Be sure you . . .

Keep Going to Page 219

"Catalysis In Practice"

That's the title of one of the books presented in this month's "Reviewing New Books." It presents the actual methods, economics and problems of catalysis as seen by ten leading practitioners in the chemical process industries. It is based on an "Experience in Industry" symposium, so be sure you . . .

Keep Going to Page 206

Another "Boxscore"

Once again this month PETROLEUM REFINER presents its quarterly compilation of refinery, natural gasoline, and petrochemical plant construction projects from all over the world. Keep Pace with construction trends by reading "Construction Boxscore"—the most complete and up-to-date guide to building in the industry.

Keep Going to Page 233

LPG Sales Soar

The feature story in this month's "What's Happening in the Industry" presents the annual round-up of LP-Gas sales and why the increase exceeds the estimated percentage increase for all other petroleum products last year. You'll want to read this article plus all the short digests of those items that made the news last month.

Keep Going to Page 276

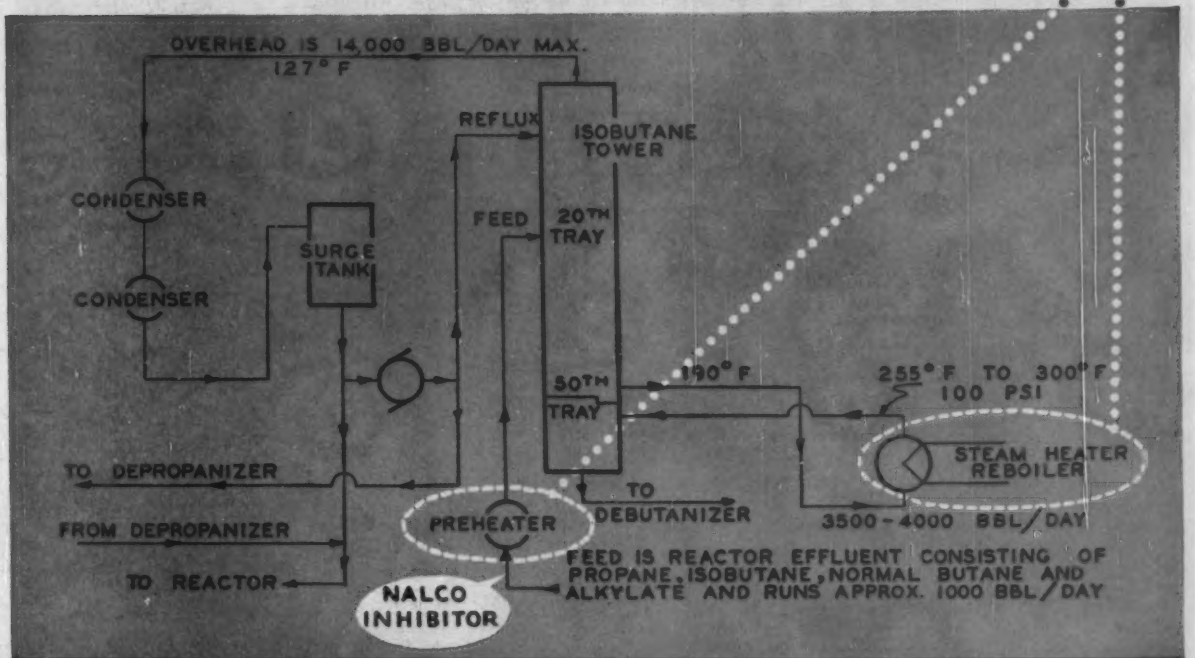
What's New?

Every month Petroleum Refiner presents a section of the magazine devoted entirely to new equipment and literature which manufacturers have announced to the previous month. You'll keep abreast of these new developments in the equipment field when you read this section every month.

Keep Going to Page 332

Nalco INHIBITORS GET RESULTS AT THESE TYPICAL TROUBLE-SPOTS

IN AN H_2SO_4 ALKYLATION SYSTEM



THE PROBLEM	THE TREATMENT	THE RESULTS
1. *Corrosion* in the preheat exchanger of the isobutane tower. 2. *Fouling* with ferric sulfate and hydrolysis products of esters of H_2SO_4 in the reboiler of the isobutane tower.	Nalco Inhibitor fed to the isobutane tower at first month rate of 20 ppm with subsequent reduction to 10 ppm.	Reboiler pressure drop held to 25-28 psi. No decrease in reboiler coefficient. No problem of corrosion or deposits during more than a year of operation with Nalco treatment.

When corrosion and fouling start to limit refinery production, you can rely on fast, thorough Nalco chemical action to effect a cure.

The earlier the treatment, of course, the simpler the problem, so if you are beginning to detect corrosion and fouling, let your Nalco Representative help you *now* or write direct for further information.

NATIONAL ALUMINATE CORPORATION
6259 West 66th Place • Chicago 38, Illinois
Telephone: POrtsmouth 7-7240
CANADA: Alchem Limited, Burlington, Ontario
NORTHWESTERN UNITED STATES, HAWAII and ALASKA: The Flox Company, Inc., Minneapolis 3, Minnesota
ITALY: Nalco Italiana, S.p.A.
WEST GERMANY: Deutsche Nalco-Chemie GmbH
SPAIN: Nalco Espanola, S.A.

THE Nalco® SYSTEM . . . *Serving Industry through Practical Applied Science*

Reviewing New Books . . .

"Catalysis in Practice"

This book presents the actual methods, economics and problems of catalysis as seen by ten leading practitioners in the chemical process industries. It is based on an "Experience in Industry" symposium jointly sponsored by the Philadelphia-Wilmington Section of the American Institute of Chemical Engineers and the University of Pennsylvania.

Included are concise chapters on catalyst choice and commercial preparation; fixed bed systems and moving bed processes; economics of catalyst use; operating problems in processing; and a truly helpful appraisal of trends and prospects in catalysis.

(Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y., 153 pages, $3.95. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

"Source Book of Industrial Solvents"

The second in a series of four volumes, this unique reference work presents a concise picture of the composition and properties of industrial solvents.

This second volume is devoted to halogens, fluorinated hydrocarbons, chlorinated hydrocarbons, bromated hydrocarbons, and iodinated hydrocarbons. Commercial and proprietary names are used instead of chemical nomenclature; the solvents are classified in accordance with their distillation range; and a wide spectrum of properties is given in tabular form for each solvent.

(Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y., 467 pages, $7.00.)

"15 Fundamentals of Combustion of Gaseous Fuels"

This Bulletin presents the results of an extensive search of the literature on the theory of combustion, combustion phenomena, experimental investigations of various phases of combustion, and certain fundamentals important to burner design. Of the literature published before Fall 1955, over a thousand references were consulted, and some two hundred have been critically reviewed. The more significant findings and opinions are summarized.

Limitations of the present fundamental understanding of several phases of the combustion process pertinent to the gas industry are discussed: a) theories of flame propagation and the method used to test these theories; b) the problem of combustion initiation with respect to flammability and ignition; c) aerated flames, including the process of inspiration of primary and secondary air and flame stability; and d) diffusion flames.

Aspects requiring further investigation for full utilization of the combustion process are presented.

(Institute of Gas Technology, Technology Center, Chicago 16, Ill., 64 pages, $5.00).

"Sparking Characteristics And Safety Hazards of Metallic Materials"

"Non-sparking" hand tools are no more effective than those of steel in preventing accidental ignition of explosive or combustible atmospheres, according to a conclusion of a Navy report just released for industry use through the Office of Technical Services, U. S. Department of Commerce.

The conclusion was reached during a survey of sparking characteristics and safety hazards of metallic materials. It was found that sparks or impacts and subsequent ignitions can result from use of low sparking materials such as copper. It was also shown that metallic sparks can be produced by contact between a non-sparking and a sparking metal.

The report includes discussions of the fundamentals of sparking theory and methods of spark testing. Volume, PB 131131 Sparking Characteristics.

(Order volume, PB 131131 OTS, U. S. Department of Commerce, Washington 25, 36 pages, $1.00).

"Brittle Behavior of Engineering Structures"

Since the brittle failure of a number of tankers and Liberty ships during World War II, there has been a profusion of papers and reports on the brittle behavior of steel in engineering structures and in a great variety of laboratory tests.

In such a large and important field, there has inevitably been some confusion, controversy and wishful thinking. Much of this should end with the appearance of this book. The significance of test methods, crack initiation and propagation, the effects of hydrogen, incidental and alloying elements, preheat and stress relief receive careful study and evaluation.

Improved design; fully deoxidized, fine grained, normalized steels; more rigid inspection; stress relief when possible; higher ambient welding temperatures; low hydrogen electrodes and other means will suggest themselves to readers of this book as a means of mitigating the brittle fracture problem. This book will be of great value to the designer, welding engineer, fabricator, inspector and user.

(John Wiley and Sons, Inc., 440 40th Ave., New York 16, N. Y., $6.00.)

1958 Oil Directories

The revised 1958 oil directories give the names, titles, and addresses of more than 80,000 important oil men who purchase or influence the purchase of equipment used in all branches of the oil industry in the world.

They are pocket-size and plastic bound —designed especially for sales executives who need a quick reference manual that can be carried conveniently.

The books cover producing and drilling, refining, petrochemical and natural gas processing plants of the world, pipe line and pipe line contractors and others.

(Midwest Oil Register, Drawer 7248, Tulsa, Okla. Prices vary for the different volumes.)

"Catalysis" vol. 5

This is the fifth in a series providing research chemists with a soundly conceived reference source on the physical chemistry of catalysis and catalytic processing.

This fifth volume includes reactions of carbon monoxide, the oxo reaction, the direct catalytic synthesis of higher alcohols from carbon monoxide and hydrogen, the catalytic hydrogenation of aromatic compounds, hydrogen isotopes in the study of hydrogenation and exchange, and the hydrodesulfurization of liquid petroleum fractions.

(Reinhold Publishing Co., 430 Park Ave., New York 22, N. Y., 542 pages, $15.00. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas, U.S.A.)

"Electron Impact Phenomena"

This volume discussed low energy impact phenomena and mass spectrometry from the viewpoint of chemical physics and molecular theory. Experimental techniques of measuring critical potentials are considered in some detail.

A significant aspect of the book is the exhaustive tabulation of data on critical potentials, ion energetics, bond strengths, and reactions of gaseous ions.

This volume should prove of value to anyone interested in the energies and properties of ions, mass spectrometry, ionic or free radical reactions, or the chemical effects of radiation.

(Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y. 349 pages, $8.50. For sale by Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas.)

Oil & Petroleum Year Book

The 1957 issue of the yearbook has been published for the forty-eighth time. The new edition contains complete and up-to-date particulars of 1070 of the principal British, American, Canadian, and foreign oil companies operating in all parts of the world, and covering all branches of the industry.

One section includes "Managers, Engineers and Agents," and there are three maps printed in red and black showing Canadian oil and gas fields and pipe lines, Trans-Canadian natural gas transmission system, and Middle East oil fields, refineries, pumping stations and pipe lines.

(Walter E. Skinner, 20 Copethall Ave., London, E.C.2, England, $6.00.)

Refrigeration, Air Conditioning and Cold Storage

This book presents the principles of refrigeration and allied subjects. It discusses in detail treatment and care of water essential in large installations, methods for combating corrosion of equipment, and water economy in industrial areas. It gives complete information on stream jet refrigeration, absorption, systems, heat pumps, electric motors, fans, pumps, steam turbines.

Every group in refrigeration regardless of how long it has been in the field can use this book profitably; for reference, for study, or for both. Management men, plant engineers and plant operators will find help in choosing the system and equipment best for any installation. They will also see how to install, operate and maintain it for greatest economy.

(Chilton Book Division, 56th & Chestnut Sts., Philadelphia 39, Pa., 1232 pages, $17.50.)

No maintenance in 2 years for these CRANE Valves

How Cit-Con handles hard-to-hold hot wax

Two years ago, Cit-Con Oil Corporation, Lake Charles, Louisiana, completely revised and modernized the operations in its wax slabbing plant.

Several 3-inch Crane 47-X cast steel wedge gate valves, with Exelloy trimmings, were installed in hot wax lines leading from the pumps. Operating temperature was 180° F., with pressure at 60 psi.

In two years' time, no maintenance service beyond ordinary inspection has been given these Crane valves—*and no leaks have developed.* The valves are operated six to eight times daily.

Do you want this kind of valve performance on hot, hard-to-hold fluids? Crane valves can help you maintain profitable, uninterrupted plant operation, cut valve replacement costs, and reduce maintenance down-time costs. For complete facts about the economy of using Crane valves *everywhere* in your plant, ask your Crane Representative.

IDEAS FOR YOU. Ask your Crane Man for a copy of "Valve Performance Facts"—a 36-page circular of on-the-job economies made with Crane valves. Or write to the address below.

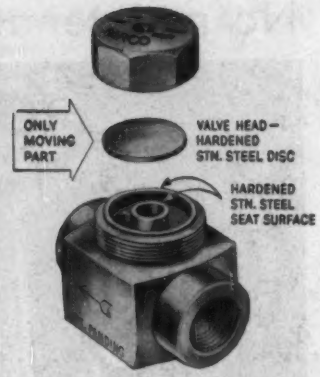
CRANE VALVES & FITTINGS

PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

For more data on advertised products, use Readers' Service Cards, last page.

HOW TO
reduce steam trap inventory and practically eliminate maintenance
with the unique Sarco TD Thermo-Dynamic



ONE TYPE OF STEAM TRAP FOR PRACTICALLY ALL APPLICATIONS

The Sarco TD Thermodynamic is the most versatile steam trap ever developed.

It has large capacity . . . but small size. Insures rapid, continuous, complete drainage of condensate at saturated steam temperature. Has high air venting capacity.

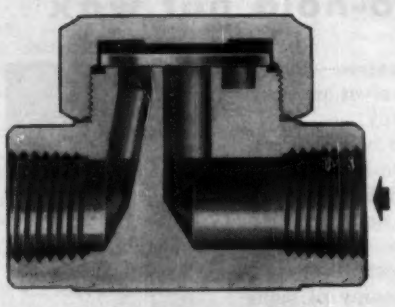
Operates perfectly on all loads . . . and when pressure fluctuates. Freeze-proof, when installed with outlet down. Highly resistant to superheat, water hammer, corrosive condensate.

ONE LARGE CAPACITY SEAT FOR ALL PRESSURES—10 TO 600 PSI

Yes, in each size Sarco TD trap the same large capacity seat accommodates all pressures 10-600 psi . . . for heavy, light, or no condensate loads. Sizes ⅜ to 1".

Self-adjusting throughout entire pressure range . . . not a single change or adjustment required.

No need to stock seats and heads for various loads and pressures. Inventory simplified and reduced.



TROUBLE-FREE DESIGN NO VALVE MECHANISM—ONLY 3 PARTS

Look at that cross-section, left. That's all there is to a Sarco TD! What could be simpler?

Only 3 simple, rugged parts (single pieces—not assemblies) . . . all stainless steel. Only *one* moving part . . . a solid hardened stainless steel disc.

No mechanism . . . the kinetic energy of steam closes the valve. No narrow channels to choke. No gaskets to leak.

Actual service experience . . . in hundreds of plants . . . under severest conditions . . . has proved that the Sarco TD PRACTICALLY ELIMINATES MAINTENANCE.

2215-B

SARCO Thermo-Dynamic TRADE MARK STEAM TRAP

60-DAY TRIAL CONVINCES

We will gladly send you a Sarco TD steam trap and strainer for 60-day trial. No cost or obligation. You buy only if completely satisfied. Advise size—⅜, ½, ¾ or 1"—and application. Sarco Company, Inc., 635 Madison Avenue, New York 22, N. Y.

THE MODERN TRAP THAT IS MAKING STEAM TRAPPING HISTORY!

How To Do It . . .

Hot area (2) turns white if temperature rises above 580 F. on reactor shells.

Chameleon-Like Paint Shows Hot Spots

Several of Esso's refining units are coated with a new paint that changes color. This colorful product began as an idea in Esso Research and Engineering's materials development laboratory of design engineering.

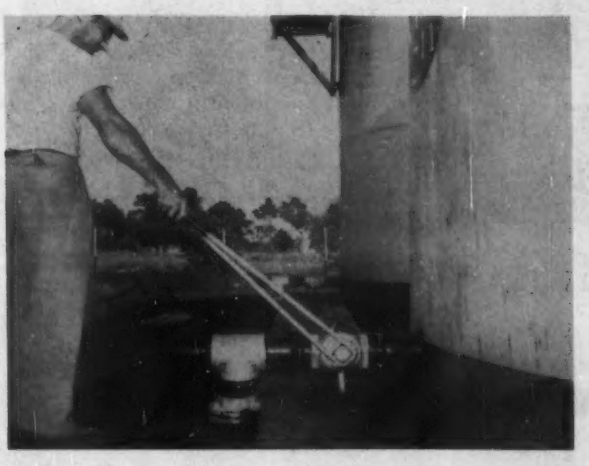
The new paint is the result of a search for a better method of detecting "hot spots" on reactor shells. This job, time consuming and tedious, was formerly done by rubbing crayon like sticks over the shell's surface. If the shell temperature was higher than the standard, the crayon mark changed color.

Today, the job of detecting dangerous metal hot spots of internally insulated vessels and pipes has been simplified through the use of this new paint which changes color at a fixed elevated temperature. Vessels requiring observation are covered with this chameleonic type paint. If the external temperature rises beyond 580 F., the affected area turns from dark blue to white.

The first field test, at Esso's Baltimore refinery, proved the paint's value. During a start-up, some hot spots showed up. These areas were approximately ten inches wide and extended around the circumferences of the vessels. The paint turned a distinct white color at these hot sections and served as the first indication of trouble to the operating personnel.

As shown in the photograph, the hot area, marked (2) turns white, while the relatively cool area, marked (1), remains dark blue in color.

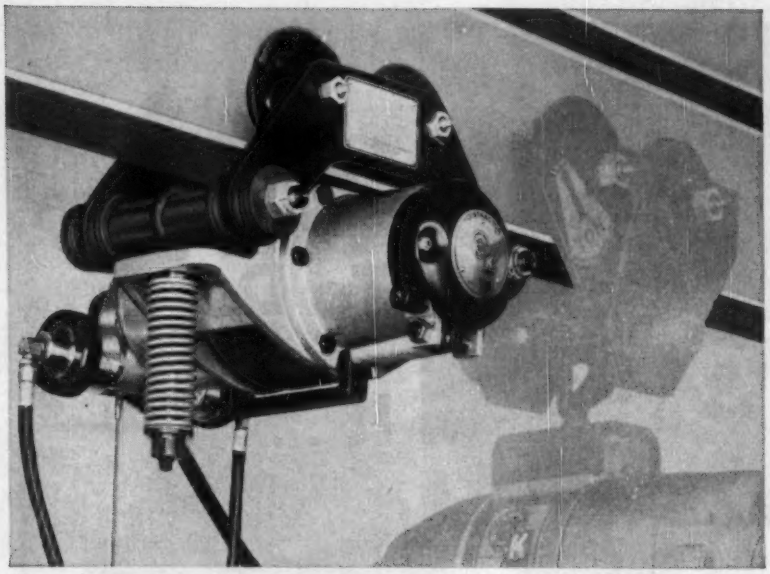
Item and photograph through courtesy *The Esso Research and Engineering News.*



Long Wrench Eliminates Bending

Where several valves of the same size are in the same vicinity, a wrench may be made which is cheap enough to be made particularly for these valves and, not being suitable for other uses such as are adjustable wrenches, it is always at hand for use on plug valves. Fabricated from three-quarter inch bar stock, a bend is made near the center of a five foot piece so that the square corners formed will fit over the square on the end of the plug. After the short end is brought back and a tack weld made in the long end, a small piece is cut to fit across the back of the plug so that the plug is "boxed in" on all four sides.

By using a long wrench which fits snugly, hammering on the plug is kept to a minimum and the adjusting nut



Now, push-pull power with new

HOISTRACTOR

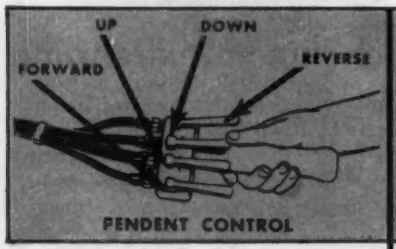
Now, it's an easy one-man, one-hand operation to raise, lower or move loads up to two tons. Simply use the new Keller "Hoistractor." This air-powered hoist trolley, connected to any beam hoist by a drawbar, rides the same beam as the hoist. Hoist lifts and lowers . . . "Hoistractor" moves hoist and load along the beam.

New HOISTRACTOR features

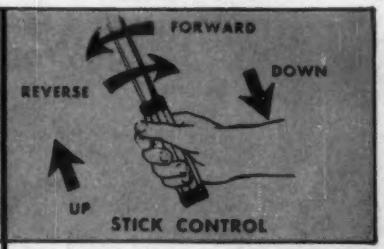
- Fast, safe movement of heavy loads—without operator fatigue.
- Speed variable from slow creep to full-load speed of 70 ft. per min.
- Axial-piston air motor exerts 250-lb. drawbar pull on beam.
- Sensitive air controls permit smooth acceleration and deceleration . . . accurate load spotting.
- Easily adjusted mechanical brake for positive stopping. Brake, not dependent on air supply, is applied automatically in event of air line failure.

Write for Bulletin 87-1.

ONE HAND CONTROL—two types available



Squeeze hand grip has up-down operating levers for hoist and fore-aft levers for "Hoistractor."



Swiveled rod with four-way grip control. Raising or lowering grip raises or lowers hoist load.

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

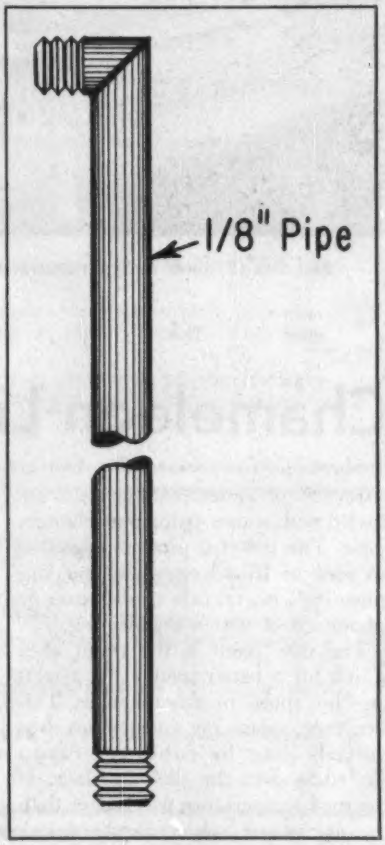
GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

How to Do It . . .

is kept tight at all times. The valve may be turned on and off by moving it through a quarter turn with the home made wrench.

Item submitted by
Harry Hess, Houston



Fitting Makes Easy Job of Greasing Trolley Wheels

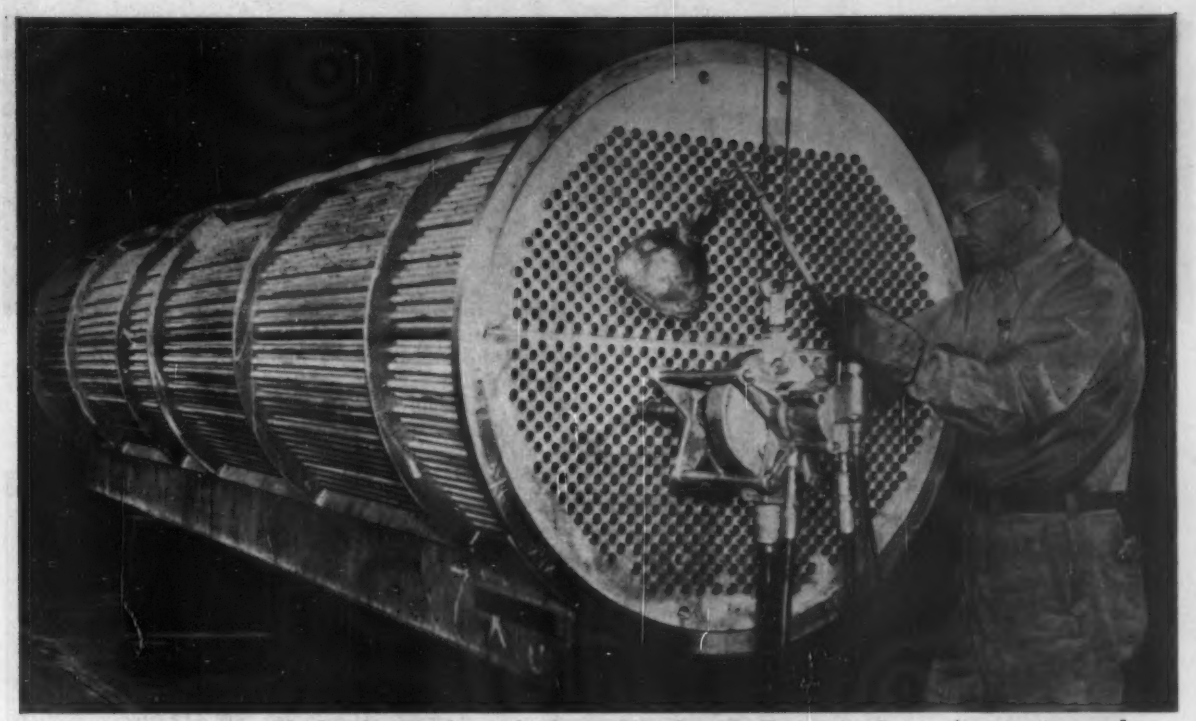
There is usually a close spacing between the trolley wheels and the bridge beams on shop cranes. Because of this spacing, it is difficult to properly grease the trolley wheels.

A specially designed fitting makes

YOUR IDEAS ARE VALUABLE!

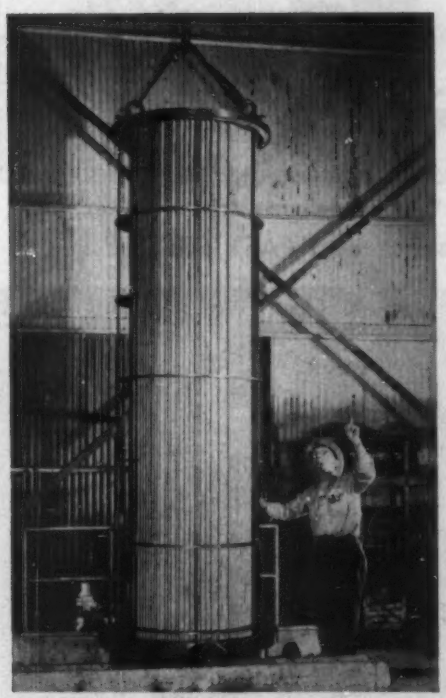
At least $10 will be paid for each idea accepted for "How to Do It." Just send a brief note with a photo or sketch to the Editor, *Petroleum Refiner*, P. O. Box 2608, Houston.

For more data on advertised products, use Readers' Service Cards, last page.



EXPANDING ENDS of Arsenical Admiralty-439 tube in tube sheet with Southwestern Engineering Company's automatic expander.

SWECO Heat Exchangers for Gulf Coast refinery tubed with Anaconda Arsenical Admiralty-439 for long service life



SOUTHWESTERN ENGINEERING CO. used this vertical method of inserting removable tube bundles to help provide a better fit and to prevent binding.

For an expansion of the crude refinery plant of a major Gulf Coast refinery, Southwestern Engineering Co., of Los Angeles, Calif., recently built a variety of shell-and-tube heat exchangers, using a total of over 110,000 lbs. of Anaconda Arsenical Admiralty-439 tube.

Anaconda Arsenical Admiralty-439 was selected, according to Southwestern Engineering, because it offers appreciably longer service life than ferrous tube for the type of cooling water involved.

Among the heat exchangers involved are top-tray reflux coolers, each with 978 tubes, ¾" O.D., 16 gage, 20' long. Each bundle has about 3800 sq. ft. of surface. Another typical unit is the fractionator overhead condenser with 1021 tubes for a total of 6400 sq. ft. of surface. Other equipment includes a debutanizer bottoms-feed exchanger, naphtha splitter reboiler and overhead condenser, as well as an amine-solution exchanger and reactivator reboiler.

FULL RANGE. Anaconda Condenser Tubes are made for all sizes and kinds of shell-and-tube, submerged, spray-tower, and finned-atmospheric heat transfer equipment—for operation at elevated temperatures in conformance with ASME standards for allowable stresses.

TECHNICAL ASSISTANCE. Our Technical Department is regularly helping companies select the correct tube alloy. This service is available to you without obligation. Write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

8789

ANACONDA®

TUBES and PLATES for CONDENSERS and HEAT EXCHANGERS

Made by **THE AMERICAN BRASS COMPANY**

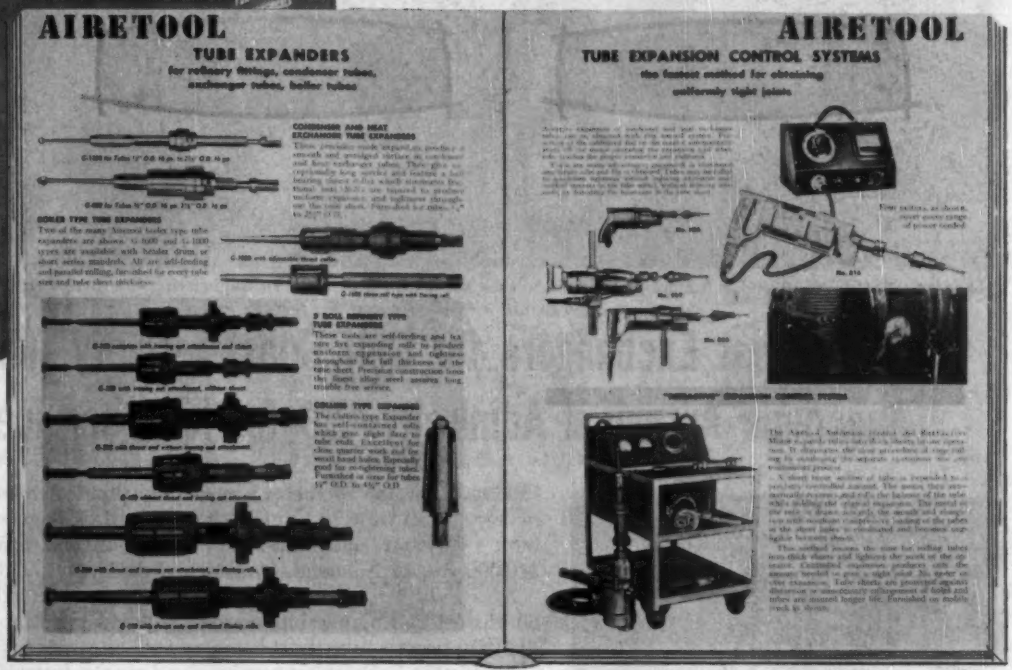
in the new REFINERY CATALOG

turn to...

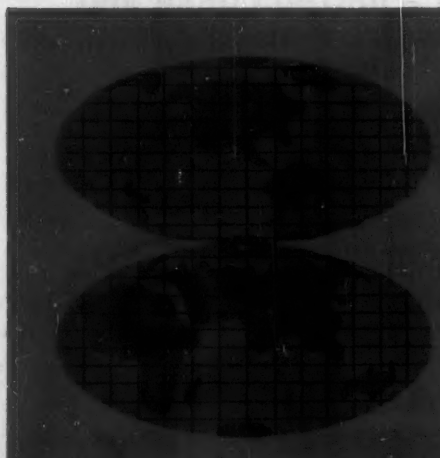
When you need tubular maintenance equipment, turn to the big AIRETOOL section in your new 1956 Refinery Catalog.

You'll find 24 pages of detailed information and illustrations on AIRETOOL equipment to perform every tube maintenance operation.

Order direct from this catalog or contact your nearby Airetool representative for helpful advice and assistance in selecting the tools you need.


AIRETOOL
TUBE EXPANDERS
for refinery fittings, condenser tubes, exchanger tubes, boiler tubes
AIRETOOL
TUBE EXPANSION CONTROL SYSTEMS
the fastest method for obtaining uniformly tight joints

Consult your copy of the Refinery Catalog — Wherever you are you can count on AIRETOOL for expert assistance and FAST SERVICE . . .



Immediate help on any problem and quick service on orders for AIRETOOL equipment to any part of the world is made possible by AIRETOOL'S network of plants, offices and representatives.

The Airetool catalog in your Refinery Catalog contains a complete listing of these locations for ready reference.

PLANTS: Airetool Manufacturing Co., Springfield, Ohio; Airetool Nederland, N.V., Vlaardingen, The Netherlands; Airetool Canada Ltd., Brantford, Ontario

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge

REPRESENTATIVES: Principal Cities in U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Japan, Hawaii

AIRETOOL

for the most complete line of dependable
TUBULAR MAINTENANCE EQUIPMENT

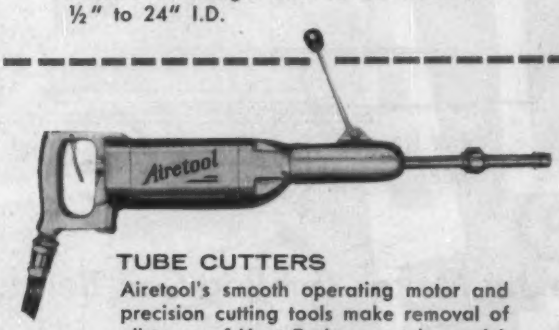
For over 27 years Airetool has been a leader in the design, development and manufacture of air powered motors and equipment for tubular maintenance. You can always turn to Airetool equipment with confidence, knowing that its dependable performance will help to keep your operation running more efficiently.

TUBE CLEANERS

Airetool has the most complete line of air motors and cleaning heads for efficient maintenance of straight and curved tubes from ½" to 24" I.D.

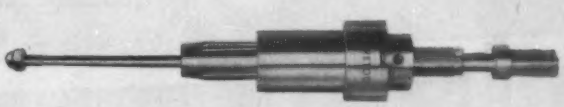
CONDENSER TUBE CLEANERS

This lightweight, powerful Airetool motor has a built-in flushing system and wide range of cleaning heads for effective condenser tube cleaning.



TUBE CUTTERS

Airetool's smooth operating motor and precision cutting tools make removal of all types of Heat Exchanger tubes quick and easy.



TUBE EXPANDERS

There's an Airetool self-feeding, parallel-rolling expanding tool for every tube size and sheet thickness.

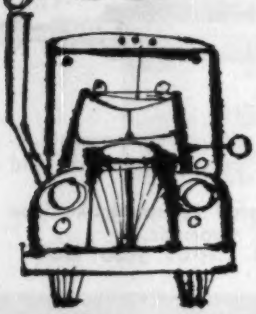
Airetool Electric Control Systems make tube rolling fast, uniform, automatic.

Newly developed by Airetool . . . a pneumatically operated unit that automatically controls expansion by accurate measurement of torque. Rolls tubes from ¼" to 1½" O.D. to uniform accuracy.

Write for new Bulletin No. 64. It gives a great deal of technical information and supplements data you already have in Refinery Catalog.

For more data on advertised products, use Readers' Service Cards, last page.

pull more diesels to your pump –deliver full power without noxious exhaust odors –just add Alamask® to your diesel fuels



It takes very little Alamask to subtract the choking odor from diesel exhaust fumes while adding to your sales. Alamask in your fuel will pull truckers, bus operators to your pump. *Selling point to truckers:* operators who tank up with your odor-controlled diesel fuels avoid the increasing demands to "put a stop to engine odors or reroute your lines." *Selling point for buses:* lines that standardize on your odor-controlled fuel increase passenger comfort both in the vehicle and in the terminal—builds good will all along the route. Why not call us about adding Alamask to your diesel fuels? Let us show you how Alamask can give you a new competitive plus.

RHODIA, INC.

60 EAST 56TH STREET, NEW YORK 22, N.Y.
(PHONE PL. 3-4850) REPRESENTATIVES IN:
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DENVER · LOS ANGELES · MONTREAL · MEXICO CITY

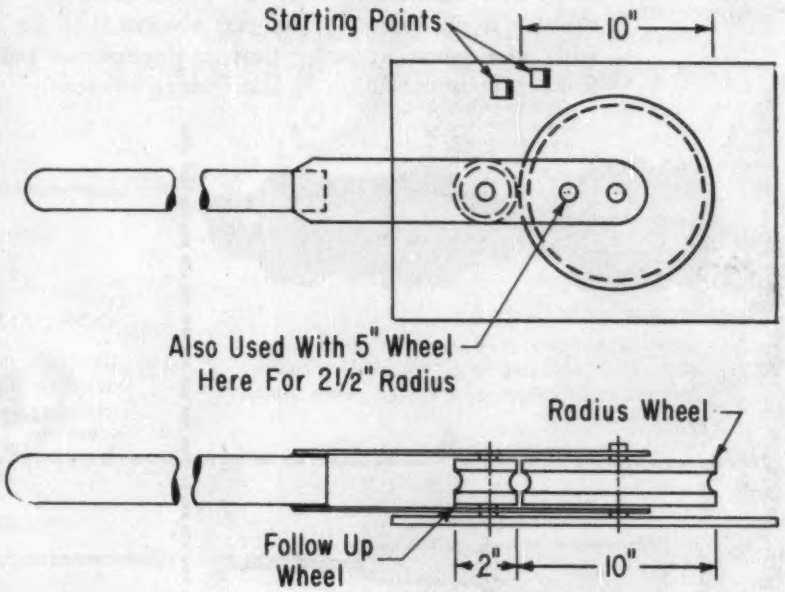
How to Do It . . .

the job of greasing the trolley wheels easy and practical.

All that is needed is six inches of one-eighth inch pipe, mitered to 90 degrees on one end and welded. Both ends are threaded to receive the grease coupling on the short end and the gun on the long end.

Total space required for this nozzle is one and seven-eighths inches. Space between wheel and beam is two and one-eighth inches. Result—a perfect fit.

Idea submitted by:
E. N. Smith, Jr.
Ethyl Corporation
Pasadena, Texas



This Simple Jig Makes Cooling Coil Bends

Cooling coil bends can be made easily with a simply constructed tube bending jig.

The working parts consist of a permanently installed follow-up wheel and two interchangeable dies. The latter will accommodate bends of two and one-half and five inch radii.

The jig's handle can be made from pipe welded between two flat pieces of bar stock two inches wide.

These working parts are fastened to the base plate by means of a pin inserted through the radius die. Two "L" shaped clips are welded to the base and act as starting points and feed guides for the tubing.

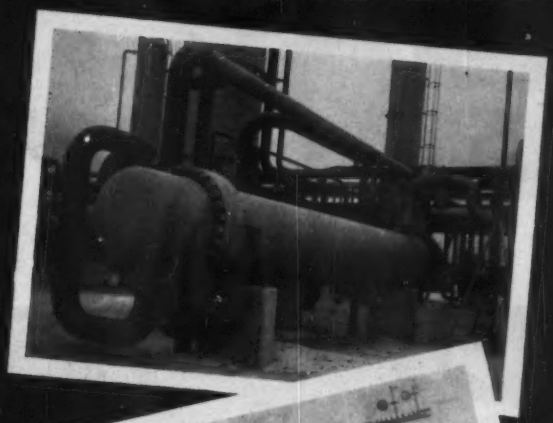
Idea submitted by:
E. B. Holstine
Ethyl Corp.
Pasadena, Texas

$$ Your Ideas Are Valuable! $$

At least $10.00 will be paid for each idea accepted for "How To Do It." All you need to do is write a brief note telling about your idea, then attach a photo or sketch (if needed), and mail it to Editor, Petroleum Refiner, P. O. Box 2608, Houston.

HEAT EXCHANGERS

FOR THE PETROLEUM, CHEMICAL, AND PROCESS INDUSTRIES



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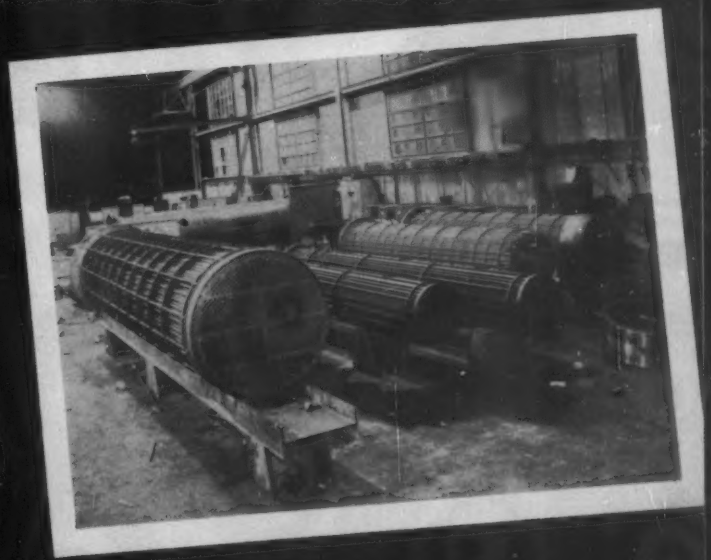
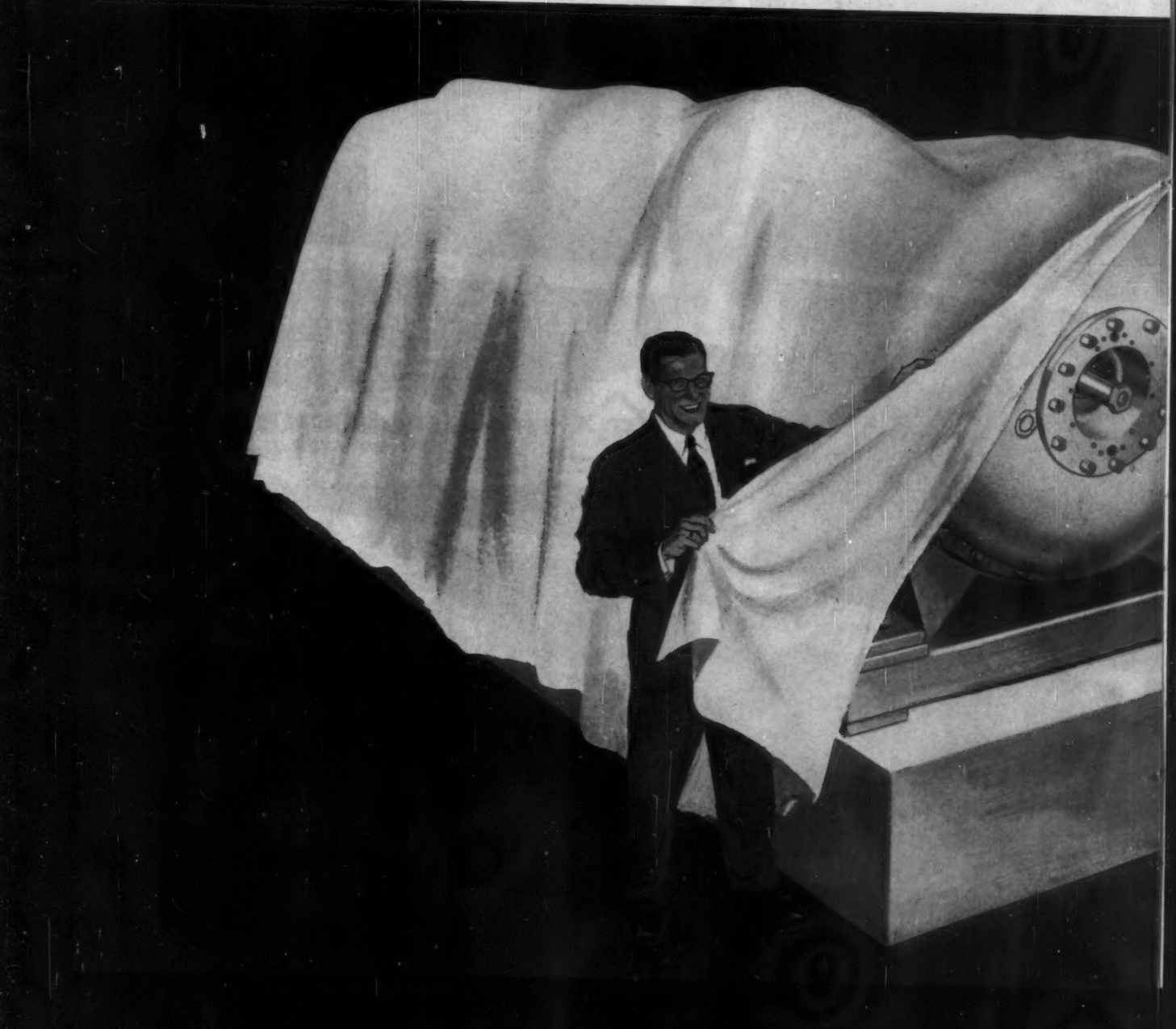


COOPER-BESSEMER

ANNOUNCES...

Micro



therm

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Fully proved, and now available in 10,000 cfm inlet capacity and up, Cooper-Bessemer MICROTHERM Centrifugals offer new principles, important new advantages in air and gas compression for the oil and gas industry, the chemical industry, wind tunnel applications and in many industrial services. For example . . .

FEATURING:

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For the first time, a digital computer is available to close the control loop automatically—to provide greater profits by increasing plant throughput, improving product quality, and decreasing operating costs. The new RW-300 Digital Control Computer is engineered specifically to solve the difficult control problems of chemical plants, oil refineries, and other process industries.

The desk-size RW-300, with built-in input and output equipment, is designed to be connected directly to process instruments and controllers. It continuously monitors the instruments, makes the required computations and decisions, and adjusts the set-points of the process controllers. In addition, it prints records of operating data. RW-300 computer control is fast, accurate, and dependable.

The computer's program of instructions, stored in a magnetic drum memory, can easily be completely revised without modifying the equipment. As a result, the RW-300 can also readily handle changing control problems such as those encountered in pilot plants and research centers. The RW-300 can in addition serve as a versatile computing data logger and as a general-purpose computer.

Ramo-Wooldridge has a staff of experienced systems engineers to handle applications of the RW-300. If your company has a problem in process control, pilot plant operation, or advanced data logging, write to: Director of Marketing, Dept. PR-801, The Ramo-Wooldridge Corporation, 5730 Arbor Vitae Street, Los Angeles 45, California.

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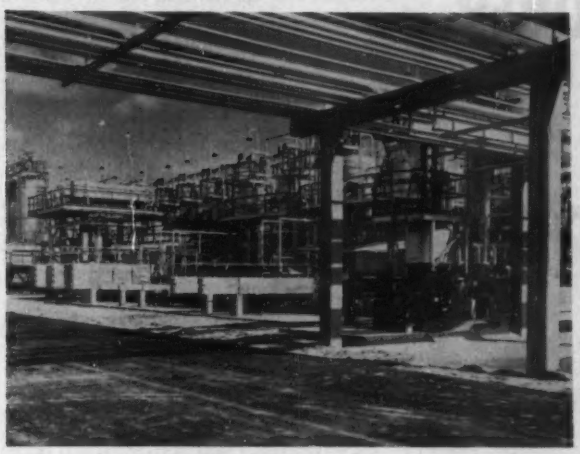
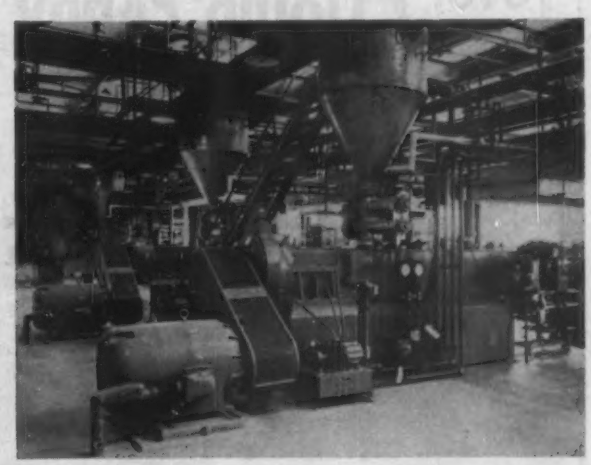
Who's Building . . .



This new high density polyethylene plant can produce 50 million pounds annually.



Strands of polyethylene leaving the extruder are chopped into small pellets.

More Plastic from New Grace Plant

Largest plant of its kind in the world will make 50 million pounds of polyethylene annually.

W. R. Grace & Co.'s Polymer Chemicals Division announced last month that its high density polyethylene plant in Baton Rouge, La., has completed its first two weeks of successful operation.

First announcement concerning Grace's initial production of the new plastic resin was made by J. Peter Grace, president of the parent organization.

The new plant with an annual capacity of 50 million pounds is the largest plant of its kind in the world to come on stream as an integrated operating unit. It is also the first polyethylene plant to be built in Louisiana.

The plant built by the Fluor Corporation Ltd., Los Angeles, was under construction for less than 15 months. The over-all investment in commercial plant, research and development facilities exceeds $18 million.

The process employed by Grace was developed and licensed by Phillips Petroleum Co., Bartlesville, Okla. As the on stream date approached, it became evident that the permanent commercial ethylene supply contracted for by Grace would be delayed as a result of equipment delays at the new ethylene plant under construction by Grace's ethylene supplier. In view of this situation a fleet of high pressure gas truck trailers was assembled to bring ethylene from east Texas and accumulate it in underground ethylene storage facilities developed by Grace's future supplier. A sufficient inventory of this "over the road" ethylene was scheduled to permit operation uninterruptedly during the interim period. The plant will continue to operate on the temporary supply of ethylene until the end of 1957, when the permanent ethylene source four miles away will go on stream.

Valuable design data resulted from the 1000-pound-a-day semi-works plant which was built by Grace at Baton Rouge at a cost of $1 million in a 16 week period starting in March, 1956. The semi-works plant served as a proving ground for many ideas subsequently incorporated into the main process. It also served as a training ground for the new plant operating employees.

Baton Rouge was selected as a site for the plant because of the availability of raw materials and transportation facilities by rail, ship, truck and air.

Standard-Vacuum Slates Bataan Peninsula Refinery

Standard-Vacuum Oil Co. late last month confirmed a Manila announcement that it had been granted a permit to build a $33.5 million refinery on the Bataan peninsula which will be the largest private investment project in the Philippines to date.

The permit was granted by the Philippines Department of Agriculture and Natural Resources to a newly-formed subsidiary, Standard-Vacuum Refining Corp. (Philippines). The company's application was based on terms on an agreement which had been recommended by

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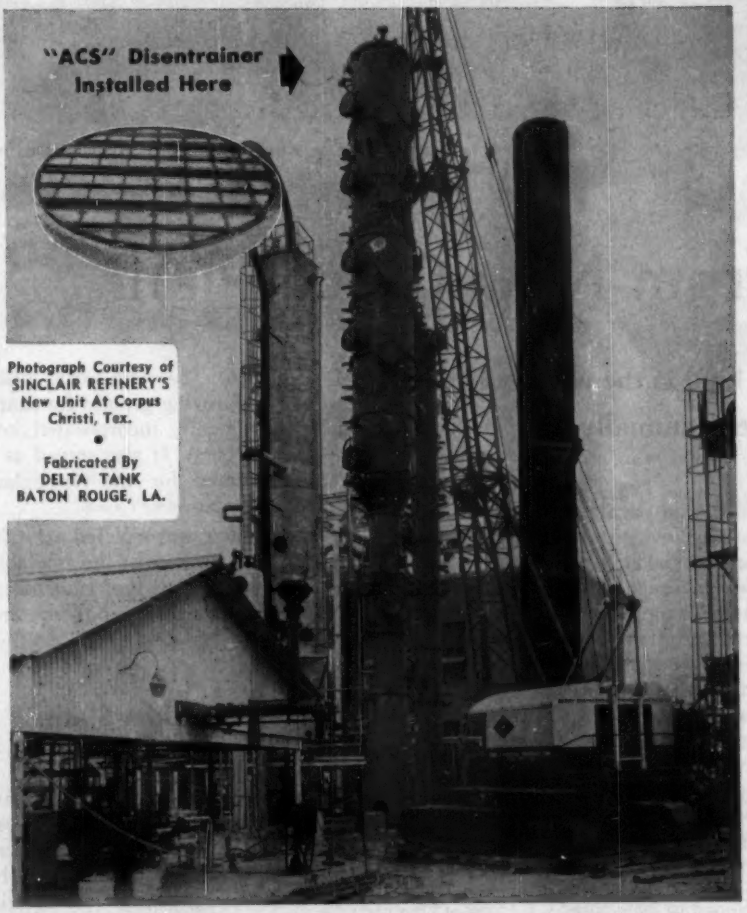
(MESH ENTRAINMENT SEPARATORS)



Photograph Courtesy of SINCLAIR REFINERY'S New Unit At Corpus Christi, Tex.

•

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ACS DISENTRAINER DIVISION

American Copper Sponge Company, Inc., 189 Charles St., Providence, Rhode Island

Who's Building...

the National Economic Council and approved by President Carlos Garcia and his cabinet and the National Monetary Board.

C. A. Larsen, Stanvac's general manager for the Philippines said the refinery will be built on a 500-acre site at Limay on the east coast of the Bataan peninsula overlooking Manila Bay.

Larsen said the refinery project will strengthen the national security of the Philippines by assuring a continuing supply of refined petroleum fuel products. Furthermore, he explained, it is expected that the plant will effect net foreign exchange savings of approximately $4.5 million yearly during the first ten years of operation.

The general manager expressed the hope that the company's current exploration program in the Philippines will some day supply the proposed Bataan refinery with crude oil. The company has invested $3 million for Philippine oil search in 1956-57.

Geared to the country's increasing needs for petroleum, now at the rate of some 43,000 bpd, the refinery is presently expected to have a design capacity of not less than 25,000 bpd. Completion is scheduled for 1961. Products will include aviation turbo fuel, motor gasoline, kerosine, diesel oils and fuel oils.

International Petroleum (Colombia) Ltd. last month inaugurated its 28,000-barrel-a-day refinery in Cartagena, along Colombia's Atlantic Coast.

Work on the refinery, which represents an investment in excess of $30 million, was begun almost two years ago. Refinery components include an atmospheric and vacuum pipe still, a model IV catalytic cracking unit, a catalytic polymerization unit, marine loading dock, and a 2 million-barrel tank farm. The plant will manufacture most major fuel products, and together with existing refinery facilities in the country will make Colombia virtually self-sufficient in refined petroleum products.

The refinery was built by Compañia Bechtel, an affiliate of Bechtel Corp. Intercol is a subsidiary of International Petroleum Co., Ltd., Coral Gables, Florida.

Shell Development Co. has broken ground for a new process development laboratory at the Emeryville, Calif., research center. It will cost approximately $500,000.

The building, covering some 10,000 square feet of ground space, will be three stories high. Portions of its interior will be open from ground to roof to allow indoor construction of 35-foot models of distallation columns and absorption towers.

The Atlantic Refining Co. has announced the completion of a new 104,000 gallon per day gasoline plant at Crane County, West Texas.

The new plant, operated by Atlantic and jointly owned with Continental Oil Co., Champlin Oil and Refining Co., and Phillips Petroleum Co., is now processing 23 million cubic feet of gas per day. The daily volumes of liquefied petroleum products extracted from the gas are 48,000 gallons

Maintenance and Steam Traps

. . . there's a relationship that goes far beyond trap maintenance alone

Good traps and good trapping have a greater effect on your maintenance costs than does trap maintenance itself. By that we mean that the right traps, properly selected and installed, and with the benefits of a preventive maintenance program, will save far more maintenance dollars than they will cost.

Under the pressure of spiralling maintenance costs, this thought becomes mighty important. Let's take a look at what it involves:

Proper Selection of Steam Traps

1. Be sure it's the right type of trap.

2. Be sure it's sized right and is for the correct operating pressure.

3. Be sure it's first rate in design and construction.

Proper Installation of Steam Traps

1. Install them so they are accessible for inspection and maintenance.

2. Install a test valve.

3. Use a union or unions.

4. Use a shutoff valve or valves.

5. Use a strainer ahead of the trap if dirt conditions are bad.

6. Use a by-pass only where continuity of service is imperative.

7. Standardize inlet and outlet connections.

Preventive Maintenance Program

1. Test trap regularly for proper operation. (Trap size, operating pressure and importance determine frequency.)

2. Inspect internal mechanism at least once a year.

You Get Indirect Benefits As Well

The direct benefits of the plan outlined are pretty obvious — good traps, properly selected, require less maintenance . . . testing and inspection prevents troubles that lead to maintenance.

However, this plan provides indirect benefits which reduce maintenance in other parts of the plant as well:

Good traps save steam and reduce the load (and consequently maintenance) on fuel handling and burning equipment and on ash handling equipment.

Good traps protect the system by eliminating water hammer and preventing the damage it can do.

Good traps discharge carbon dioxide before it can go into solution to form corrosive carbonic acid —less corrosion, less maintenance.

Good traps increase production to reduce the length of time equipment must operate or reduce the amount of equipment needed . . . either way maintenance is reduced.

How to Go About It (The Sales Pitch)

We admit we're prejudiced, but we don't think there is any better way to select steam traps than with the help of the 44 page Armstrong Steam Trap Book. Here in a single source is specific data on the selection and sizing of traps, how to install them for best results, and how to maintain them most economically.

The Steam Trap Book will also give you full information on the design and construction of Armstrong Inverted Bucket Steam Traps that offer these important maintenance-reducing advantages:

1. Armstrong Traps are dependable.

2. Armstrong Traps require no adjustments — go from full load to zero load automatically.

3. Armstrong Traps are self-scrubbing—ordinary dirt conditions can't hurt them.

4. Armstrong Traps have long-life parts — valve and seat are heat treated chrome steel — lever assembly and bucket are stainless steel.

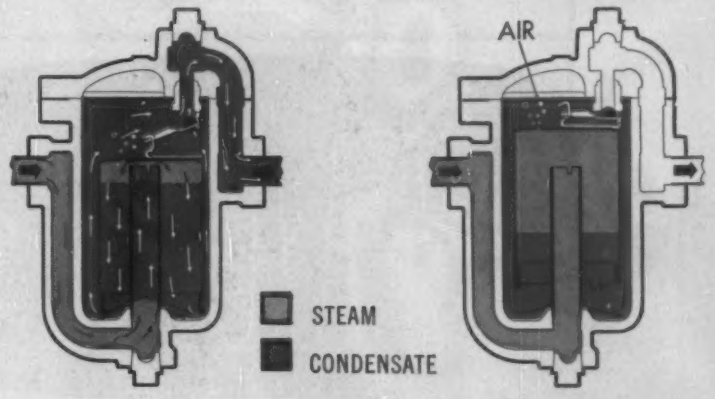
5. Armstrong Traps have water sealed valves to minimize wire drawing and erosion.

Ask for your copy of the Steam Trap Book—there is no obligation. Then test Armstrong Trapping. If you are not completely satisfied with the results, you can return the traps for a full refund of the purchase price. You can't lose much that way. Call your local Armstrong Representative or Distributor, or write

Armstrong Machine Works
8521 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

HERE'S THE STEAM TRAP DESIGN THAT CAN REDUCE YOUR MAINTENANCE PROBLEMS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

For more data on advertised products, use Readers' Service Cards, last page.

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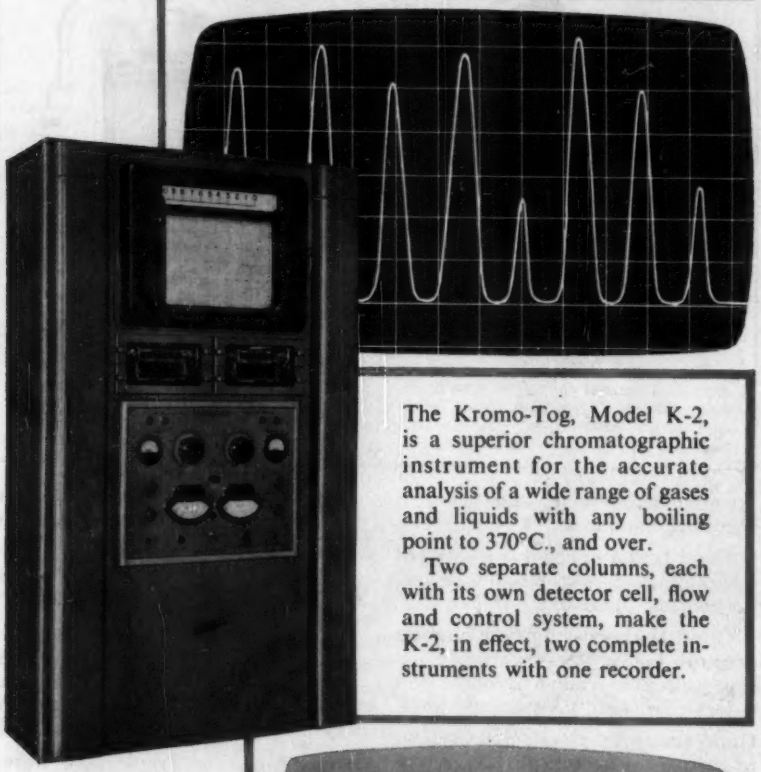

The Kromo-Tog, Model K-2, is a superior chromatographic instrument for the accurate analysis of a wide range of gases and liquids with any boiling point to 370°C., and over.

Two separate columns, each with its own detector cell, flow and control system, make the K-2, in effect, two complete instruments with one recorder.

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- TWO EXTRA SENSITIVE DETECTOR CELLS
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THE BURRELL KROMO-TOG • Model K-2, Pictured

Complete instrument for dual column operation, with two complete cells and flow systems, and electronic recorder.

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Who's Building . . .

of propane, 36,000 gallons of butane, and 20,000 gallons of 12 lb. gasoline.

The plant was constructed by the Delta Engineering Co., Houston.

Anderson-Prichard Oil Corp. has awarded a contract for the construction of an HF alkylation unit at its Arkansas City, Kans., refinery to The Refinery Engineering Co., Tulsa. The unit will have an ultimate capacity of nearly 2500 barrels a day of finished motor alkylate. By-products will be salable LPG and propane.

The unit will charge a mixed stream of propylene and butylene. It will be air cooled initially, but provisions will be made for converting to refrigeration with Freon 12. This feature will permit production of a still-higher quality gasoline.

The Refinery Engineering Co. will design, enginter, and construct the unit. Completion is scheduled for the third quarter of 1958. The unit is licensed by Universal Oil Products Co.

Eastman Chemical Products, Inc., subsidiary of Eastman Kodak Co., reported that production of the new medium-density polyethylene has begun at the Texas Eastman plant in Longview, Texas. Over-all polyethylene production capacity at the plant will be increased by more than 50 percent to 85 million pounds per year by the end of 1958. This will be the third expansion of polyethylene capacity since 1954.

Getty Oil Gesellschaft is a recently-founded German subsidiary of Getty Oil Co., set up to build a refinery in the lower Rhine River region. The company was reported negotiating with officials of the town of Rees for property and permits that would establish the site. The new plant would process Middle East crude and produce fuel oil primarily.

American Petrofina Co. of Texas has awarded a contract for the construction of a platformer and an alkylation unit at Mount Pleasant, Texas, to J. F. Pritchard and Co., Kansas City, Mo. The company, formerly American Liberty Oil Co., is now a division of American Petrofina, Inc.

The contracts total approximately $2 million. The company has launched an additional $850,000 improvement program, including increased storage capacity, laboratory expansion and a gasoline vapor recovery system. The construction program is scheduled for completion within ten months.

The platformer, a Universal Oil Products Co. process, will have a capacity of 3000 barrels per day of charging stock. The HF alkylation unit, also a UOP process, will have a capacity of 1500 barrels per stream day.

The Goodyear Tire & Rubber Co. has completed new production facilities at a cost of approximately $2.75 million which will boost rated capacity of its Akron, Ohio, synthetic latex plant to 27,500 tons annually.

The expanded facilities, coupled with

For more data on advertised products, use Readers' Service Cards, last page.

THIS MAN CAN ADD TO YOUR PROFIT PICTURE. This is a Dowell service engineer—on the job. His knowledge and abilities in chemical cleaning can help you to greater profits. Recently, an eastern corporation used Dowell Service for its boiler cleaning maintenance. Dowell's service engineer studied the problem, did the job. His use of chemical solvents in cleaning tubes and other metal surfaces was effective. On the basis of Dowell Service, this company will realize improved profits of $440,000.

There are three ways you can clean your plant equipment: *Mechanically* with your own crews—inefficient, time consuming and expensive in today's industrial pace. *Chemically* with your own crews—again inefficient and unprofitable because of heavy payroll and the personnel's lack of qualification. Or with *Dowell Service*, the modern chemical cleaning method.

With Dowell Service you receive the benefits of more than fifteen years experience in chemical cleaning—plus special equipment, chemicals, research and trained personnel. You pay one charge, get an efficient job, handled by knowledgeable people.

Every industry can profit from Dowell Service. Ask your maintenance and operating engineers if they have thoroughly investigated the profit possibilities of using Dowell Service. DOWELL INCORPORATED—A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY. Headquarters and research center, Tulsa, Oklahoma; 165 offices and stations to serve you.

Chemical cleaning service for industry DOWELL

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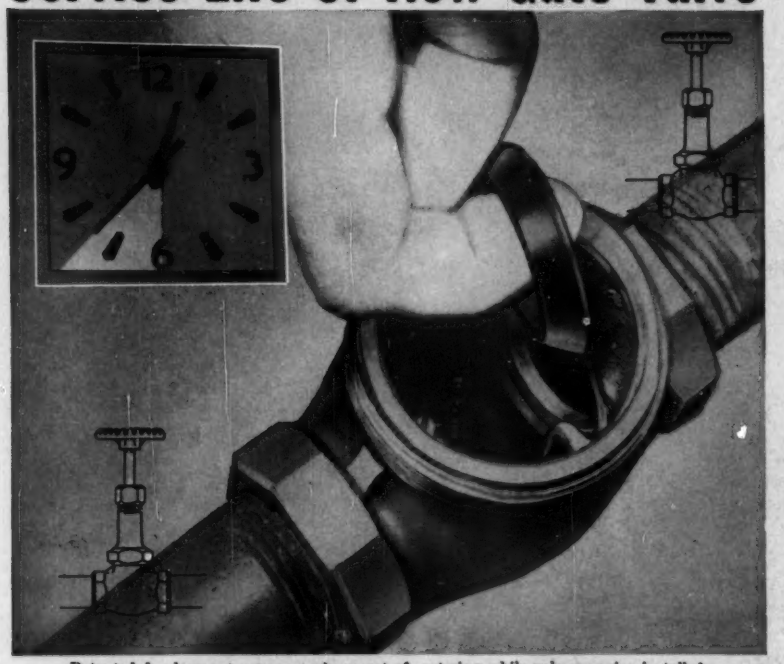
Only 7 to 10 Minutes to Renew Service Life of New Gate Valve



Patented development assures replacement of seat ring while valve remains installed.

Without removing the valve body from the line, you replace the nickel-alloy seat rings in Fairbanks new patented Renewable Seat Ring Gate Valves. In 7 to 10 minutes, from the time the line is shut down until it is put back into operation, you have given a new service life, a new life of dependable tight closure to your valve.

Just 7 to 10 minutes of your maintenance man's time — only 7 to 10 minutes of "down-time" on your steam, water or process piping lines — and you have the equivalent of a new valve in the line. Think of the savings: where once at least one hour, under the most ideal conditions, was required to replace a gate valve in the line, the job is now accomplished in from 7 to 10 minutes.

Field tested for over two years, under all conditions from steam to corrosive liquids, the revolutionary new Fairbanks Renewable Seat Ring Bronze Gate Valve has proven completely satisfactory — absolutely dependable.

Made with either rising stem or non-rising stem construction in ½", ¾", 1", 1¼", 1½" and 2" sizes, the Fairbanks Renewable Seat Ring Bronze Gate Valves are recommended for severe service conditions on 200 lb. steam pressure at 550 degrees F., 400 lb. water, oil or gas pressure — non-shock — lines requiring full flow and subject to frequent operation. Nickel alloy seat rings and wedge make the valves particularly tough and corrosion resistant.

YOURS ON REQUEST: Illustrated, descriptive folder gives complete information on Fairbanks Renewable Seat Ring Gate Valve with details and specifications. Yours without charge. Write today.

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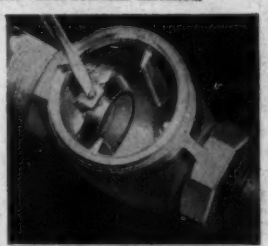
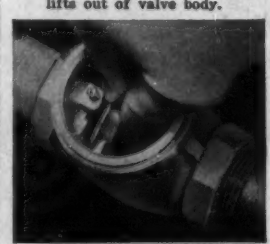


1. Union Bonnet removed. Retaining screw loosened with ordinary screwdriver.

2. Finger hooks inside nickel alloy seat ring. Seat ring lifts out of valve body.



3. New seat ring is inserted. Retaining screw tightened. Bonnet replaced.

Who's Building...

Goodyear's Houston plant currently producing dry type synthetic rubber at the rate of 220,000 tons annually, give the company a capacity of 247,500 tons annually.

The J. B. Beaird Co., Inc. Shreveport, La., a subsidiary of American Machine & Foundry Co., will enter the Canadian oil industry with a more than $1.5 million order for packaged compressor plants for Goliad, Ltd., and Texaco Exploration Co.

The new 660 horsepower 12SVG packaged compressor plants will be installed in the Pembina Field, Alberta, Canada. Beaird's Canadian affiliate, Beaird International, Inc., will supervise the project. The company will sub-contract with Canadian firms for the fabrication work on the new order. Engineering work will be carried out in the company's engineering department here.

Standard Oil Co., of California has awarded The Fluor Corp., Ltd., a contract in excess of $2 million to design, engineer, and construct a 275,000 pounds-per-hour steam generating plant and attendant facilities at its El Segundo, Calif., refinery.

The new plant, to be installed as a part of an existing catalytic cracking unit, will use both natural gas and catalyst regenerator flue gas, burned simultaneously, as fuel.

Fluor has started engineering work on the job and construction is scheduled to begin August, 1958, with completion set for March, 1959.

Foster Wheeler Corp. will build a 10,000-bpd alkylation unit at Esso's Baton Rouge refinery. Basic process design by Esso Research and Engineering; mechanical design, engineering and construction by Foster Wheeler. This unit is a duplicate of one now being constructed at Esso's Bayway, N. J., refinery.

ANIC of Italy has concluded licensing agreements for construction of a Houdry Dehydrogenation Process unit. The ANIC unit will have a nominal design capacity of approximately 20,000 short tons of butadiene annually.

Engineering of the unit is now underway at Houdry. The unit will be constructed at Ravenna, Italy, where ANIC is building a plant for synthetic rubber and also nitrogen fertilizers.

ANIC is controlled by E.N.I. (Ente Nazionale Idrocarburi), an economic agency established by the Italian state, which is sole lessee in prospecting, extracting and transporting oil and gas in the Po valley.

The Creole Petroleum Corp. will construct a $7.65 million lubricating oil plant at the Amuay Refinery on the Paraguana Peninsula northeast of Lake Maracaibo in Venezuela.

Completion of the plant with a capacity of 700 bpd is expected in 1958.

An innovation at the new plant will be

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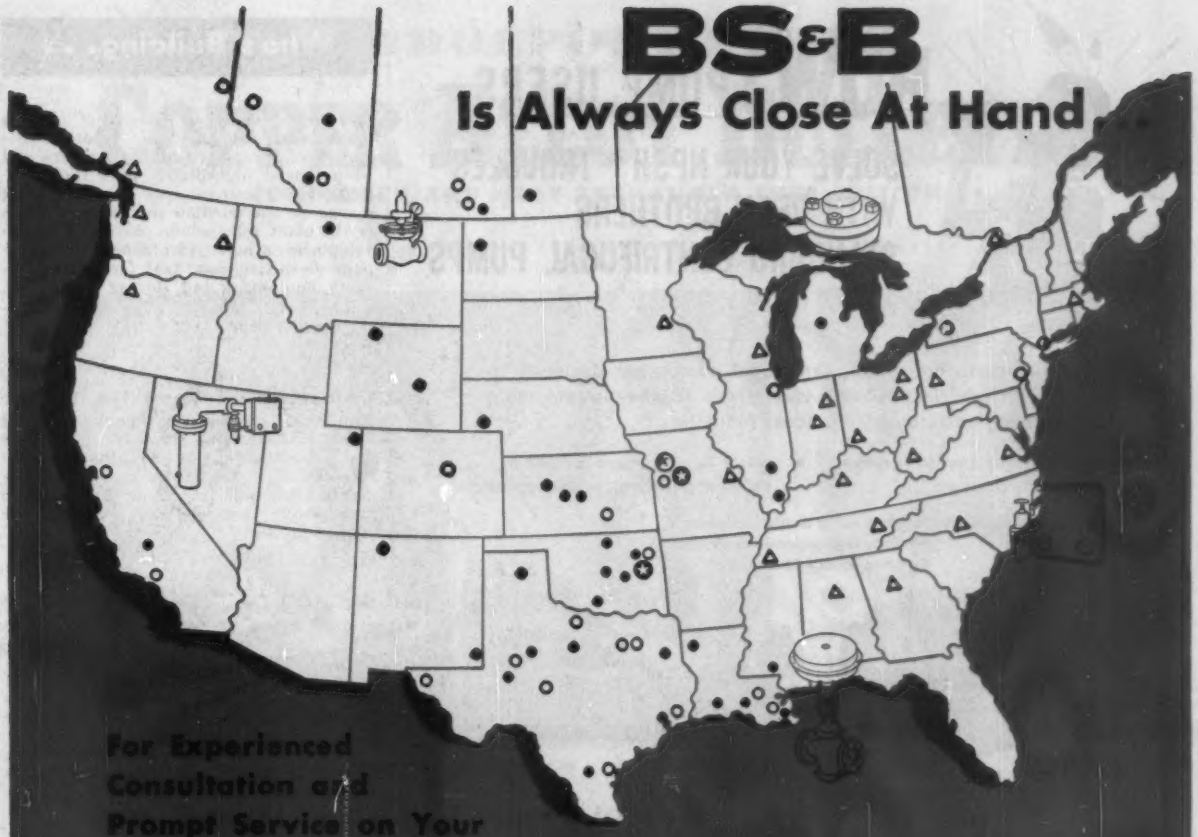

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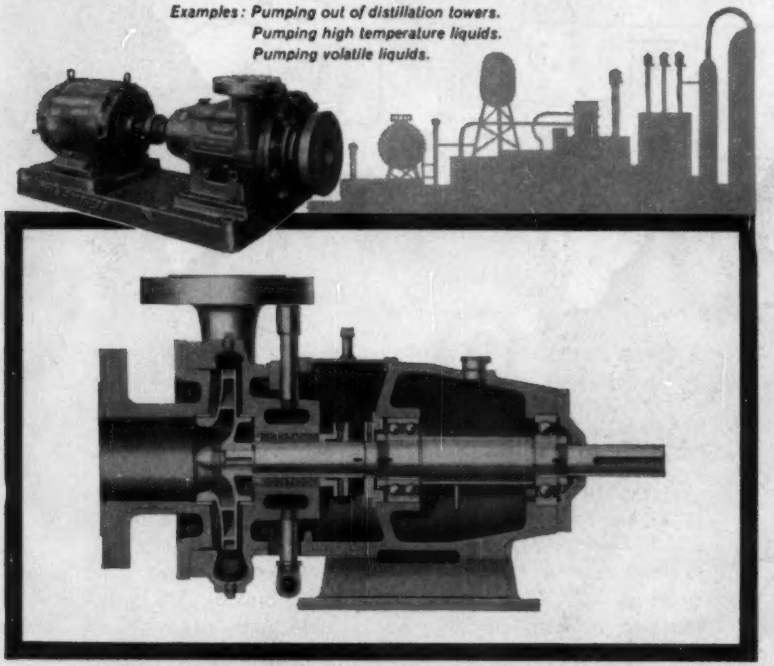
HOW! PUMP USERS—

SOLVE YOUR NPSH* TROUBLES WITH DEAN BROTHERS STANDARD CENTRIFUGAL PUMPS

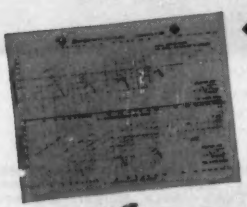
These standard, horizontal, centrifugal pumps are designed to operate with low **Net Positive Suction Heads*. This keeps equipment and operating costs down in process industries . . .

- where the pump suction is under low absolute pressure,
- where liquid pumped is close to its vapor pressure due to temperature.

Examples: Pumping out of distillation towers. Pumping high temperature liquids. Pumping volatile liquids.



The low *NPSH* requirements of Dean Brothers standard centrifugal pumps result from the design of the impeller for low inlet losses—without danger of cavitation and the resultant loss of head and capacity.



Dean Brothers offers a series of charts showing the relationship between pump rotative speed, pump capacity and NPSH. Process designers find them valuable in sizing and locating vessels and pumps on flow sheets as well as for the trouble-free application of pumps. They're **free**. Write for Curve No. S-1 A.

DEAN BROTHERS PUMPS INC.

EST. 1869

323 West 10th St., Indianapolis 7, Ind.

EXPORT OFFICE: 50 CHURCH ST., NEW YORK 7, N.Y. • CABLE ADDRESS—*BROSITES NEWYORK*

Who's Building . . .

the use of hydrogen instead of clay in finishing of the lube oils. Another new feature of the plant is that lubricants will be packaged immediately after their production to eliminate tank storage, except during the intermediate processes. Facilities of the plant will include phenol extraction equipment; a lube hydrofining unit; a propane de-waxing unit; tank farm and packaging equipment and storage equipment.

The Foster Wheeler Corp. is constructing the new plant.

Compagnie Fives-Lille, a French firm, heads a group of companies that will build a 10,000-bpd refinery, Paraguay's first. Location is at Asuncion, at the terminus of a new 422 mile, six and five-eighths-inch pipe line to be built by the same group from Bolivia, source of the crude.

Shell Oil Co. is considering a $600,000 project aimed at production of a wide range of solvents for its Vancouver refinery.

Facilities to provide for manufacture of solvents, particularly those used in the dry cleaning, paint and varnish industries are to be installed within the next year.

There is now no native supply of these solvents in British Columbia and all must be imported.

Jefferson Lake Sulphur Co.'s new Taylor Flats, B. C. sulphur plant has commenced production and the company is planning construction of another a short distance east of Calgary.

The Taylor Flats plant has capacity of 100,000 tons of sulphur annually.

The company has also announced intention to form a Canadian subsidiary for financing and development of the plants.

Excelsior Refineries, Ltd. is considering a spring construction start on a new $1.5 million refinery at The Pas, Manitoba.

Plans call for construction of a plant capable of handling between 2000 and 4000 barrels of crude daily.

National Cooperative Refinery Association is starting a modernization program at its McPherson, Kansas, refinery. This program will eventually permit crude runs to be increased above the current 28,500 barrels per stream day level.

The $1.8 Million project includes the revamping of the crude, coking and alkylation units, as well as offsite work. The Refinery Enginering Co., Tulsa, has the contract for engineering and construction of the three major items and some of the offsite facilities.

Completion of the entire project is set for the fourth quarter of 1958.

Revamping of the coker includes the addition of a new combined flash and fractionating tower with new heat-exchange and steam-generation equipment.

The crude revamp includes a new reboiler heater on the prefractionator, re-

For more data on advertised products, use Readers' Service Cards, last page.

BRIDGEPORT BRASS

COPPER ALLOY BULLETIN

CONDENSER AND HEAT EXCHANGER TUBE EDITION

Inlet end of first pass of heat exchanger blocked by trash.

Cleaning Methods that Insure Longer Tube Life and Greater Operating Efficiency

The high cost of foreign matter in condenser tubes is all too well known. Slime, marine organisms, silt, cinders and trash —all create the common costly problems of decelerated heat transfer and accelerated corrosion.

An effective tube-cleaning program is of prime importance in helping to keep operating costs at economical levels. As with all conditions of heat exchanger and condenser tube operation, cleaning methods vary in virtually each situation, depending, of course, on the nature of contamination.

In some applications rubber plugs are found to be effective. Brushes and scrapers, too, shot through the tubes by compressed air or water can clear lodged debris. Sometimes, these methods are not wholly satisfactory; the presence of stubborn debris may call for "rodding." Maintaining strainers and using rotating or stationary screens are preventive maintenance aids that pay dividends.

Scale Removal

The use of acids or strong alkaline solutions, which are inhibited to reduce corrosion of the tubes, can often dissolve or loosen scale or slime on the tube walls. Here, again specifics must be known before the correct cleaning solution can be formulated to effectively solve the problem. Very important is the alloy itself; full familiarity with its chemical make-up is essential so that the cleaning solution attacks only the scale and not the metal.

Slime Prevention

A properly set-up schedule of chlorination is highly effective against the formation of slime on tube walls. Water characteristics must be taken into account before the correct concentration of chlorine in the water can be arrived at. Over-chlorination can result in accelerated corrosion by rupturing the protective film on the tube surface. When the chlorination procedure is satisfactory, a red-brown or amber-colored film forms on the tube surface. Slime decomposition also can lead to the formation of ammonia, particularly during shutdown or stand-by, which may initiate stress corrosion-cracking of copper alloys with a high zinc content.

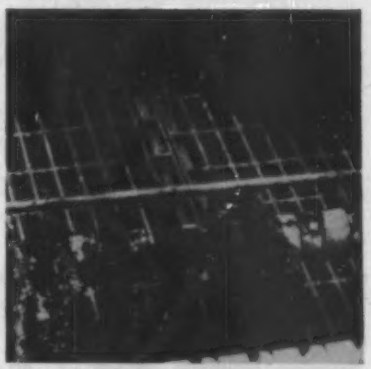
Biofouling

Biofouling organisms should be promptly removed from the tube surface by persistent scrubbing with a stiff brush and water. When these organisms die and dry on the tube surface it is doubly difficult to remove them, especially those with calcareous bases such as barnacles. When allowed to remain, the decomposition products of these organisms destroy the corrosion film and thus create a focal point for corrosion pitting. Increasing water velocity, when feasible, prevents the organisms from getting a fast hold, and is often helpful in reducing tube corrosion and maintaining heat transfer.

Biofouling in unchlorinated sea water.

Bridgeport Technical Service

You can always get help on your cleaning problems from Bridgeport Technical Service. Our familiarity with heat exchanger and condenser tube operation—under all conditions of contamination, both at sea and ashore—can help in analyzing your specific cleaning problem and result in a cleaning procedure that will help your tubes "live longer." For any information on the subject of tube hygiene, write or call the Bridgeport Sales Office nearest you.



Control of biofouling by chlorination of sea water.

BRASS Bridgeport CO.

BRIDGEPORT BRASS

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In Canada: Noranda Copper and Brass Limited, Montreal

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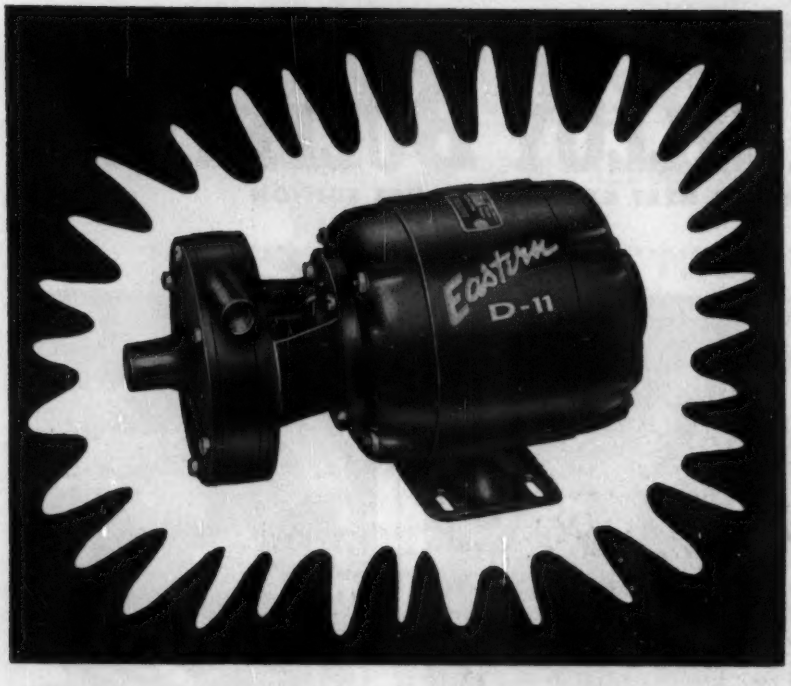

24,830 successful installations!

EASTERN D-11 CENTRIFUGAL PUMP

Why is the D-11 so successful among original equipment manufacturers? *Size and weight* make it ideal. The D-11 is the smallest, close-coupled, single-stage centrifugal pump available with an induction type motor. Eighteen pounds of compact design (9¾" x 4⅝") make it excel in industrial and process equipment, as well as laboratory service, and pilot plant operations.

SPECIAL METALS

A full selection of metals make the D-11 and other Eastern Centrifugal Pumps versatile performers. Available in 18-8 Type 303 and Type 316 Stainless Steel, Monel, Hastelloy "C", Cast Iron and Bronze, Eastern Pumps range from ⅛th to ¾ H.P. with capacities up to 70 G.P.M., pressures to 65 P.S.I.

For complete specifications on all Eastern Centrifugal Pumps, request Bulletin 120-L

Eastern
INDUSTRIES, INC.
100 Skiff St., Hamden 14, Conn.

Who's Building...

vamp of the prefractionator column, addition of new heat-exchange and pumping equipment, revamp of the main fractionator and side-cut strippers, and addition of new heat-exchange equipment.

Revamp of the alkylation unit will be the first step in converting the unit to the use of propylene as feedstock. The unit currently uses butylenes, but will eventually be able to charge both, combining them with isobutane to produce a high-quality gasoline component.

Socony Mobil Oil Co. has awarded a contract for construction of a 19,000-bpd delayed coker unit at the Paulsboro, N. J., refinery to The Lummus Co., New York.

Construction of the unit will begin in the first quarter of 1958 with completion scheduled for early 1959. The coker will upgrade heavy residual oils into gasoline and fuel oils. In the process, it will produce an estimated 765 tons of coke a day.

Hercules Powder Co. has completed its plant for the commercial production of polypropylene. The plant, which is located at Parlin, N. J., is the first commercial polypropylene plant in North America, and will have an annual capacity of 20 million pounds.

Mitsui Petrochemical Industries, Ltd., has acquired a license to a Scientific Design Co.'s liquid-phase, air-oxidation process for the production of terephthalic acid, dimethyl terephthalate and other aromatic intermediates. The new processes will be used at Iwakuni City where the first phases of a $30 million petrochemical project is underway. The 15 million pound per year plant will go on stream in 1958.

Commonwealth Oil Refining Co. recently appropriated funds to allow expansion of Ponce Refinery capacity from 58,800 to 75,000 barrels per day.

Red China claims to have completed construction of a refinery in the desolate Tsaidam Basin to process crude oil discovered and produced there within the past two years.

Chemische Werke Huels, operator of a monostyrene plant at Cubatao, was reported to be planning to expand output.

British Petroleum Co., Ltd., has begun work at its Kwinana refinery in Western Australia on the erection of a catalytic reformer. The reformer, which will be capable of a throughput of 10,000 barrels daily, will cost about $8 million.

Some of the equipment is already on the way from the United Kingdom to Kwinana, but as much as possible of the material is being purchased in Australia. The erection of the new unit will be supervised by British

For more data on advertised products, use Readers' Service Cards, last page.

ANNOUNCING NEW DEKORON INSTRUMENT TUBING HARNESS

fire resistant
impact resistant

FLAME RETARDANT OUTER SHEATH
FIREPROOF AA ASBESTOS
YOU CAN BURN IT
YOU CAN BANG IT
YOU CAN BURY IT
EXTRA HEAVY THERMAL and SHOCK ABSORBER
NEW LINEAR POLYETHYLENE

You can't beat all-plastic Dekoron Poly-Cor for chemical resistance or for ease of installation. And now, the *new* Dekoron Instrument Tubing Harness adds yet another revolutionary feature—*fire resistance.*

For example, in the direct flame of a cutting torch, it lasted longer than any other multiple-tube harness. Use it in areas where flash fires are a hazard. And *new* Dekoron Instrument Tubing Harness is rugged, too. You can bury it and forget it.

You get all the advantages—chemical, impact and fire resistance—with *new* Dekoron Instrument Tubing Harness. Remember, you can burn it . . . you can bang it . . . you can bury it. And you can *buy it now.* AA-6168

Dekoron® products

QUALITY • RESEARCH • SERVICE

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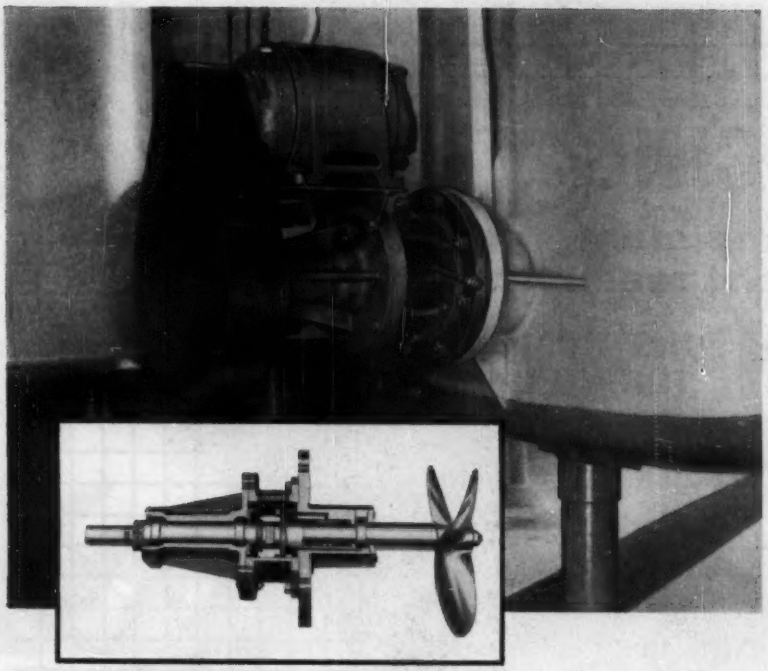


Use Existing Tankage More Effectively . . . with Agitation Engineering and Equipment by NETTCO!

Benefit from application engineering skills acquired in developing the most complete agitator line available today. Be sure your fluids are mixed or blended to complete uniformity . . . in the shortest possible time . . . by equipment specifically designed for your particular job. Check some of the design features found on Nettco's SIDE DRIVE agitator line!

NETTCO "Engineered Agitation" design features . . .

- **Mechanical seals minimize maintenance; make any maintenance required simple, quick, and inexpensive.**
- **Designs permit seal inspection and service under full tank pressure.**
- **Oversize bearings fully enclosed, widely spaced, mounted outside tank — provision for automatic running-position realignment.**
- **Models available in 1/3 to 30 HP sizes; belt driven, chain driven, gearmotor driven, or direct motor driven to suit requirements.**
- **Mechanical seals (with replaceable elements) completely interchangeable with conventional stuffing boxes.**

Send your process specifications to NETTCO agitation engineers for recommendations. Request Bulletin 532 for data on the variety of sizes, motor mounts, speed reduction designs, and stuffing box modifications available. Write now! New England Tank & Tower Co., 81 Tileston Street, Everett 49, Massachusetts.

NETTCO
ENGINEERED AGITATION SPECIALISTS

FREE LITERATURE

Please send me the following literature:

- ☐ Tank Top Agitators—Bulletin 551
- ☐ Portable & Tripod Mixers—Spec. Sheets
- ☐ Pipeline-Flomix®—Bulletin 531
- ☐ Side Entering—Bulletin 532

Who's Building . . .

and American engineers, and it is expected that the unit will be on stream by the end of 1958.

Several large tanks for the storage of both crude oil and refined products are also being erected at Kwinana.

Union Carbide Corp. will build a new plant which will provide a major increase in the production of liquid epoxy resins at Marietta, Ohio. The newly authorized facilities, scheduled for commercial operation early in 1959, will have a rated annual capacity of 15 million pounds of epoxy resins.

Plant construction and operation, as well as sales and technical services connected with the promotion of these materials, will be handled by Bakelite Co., division of Union Carbide Corp.

Shell Oil Co. has awarded a contract for the construction of a new laboratory at its Norco refinery to Tellespen Construction Co., of Houston.

The electrical work has been sub-contracted to Lambert Electric Co., New Orleans, and the plumbing and air-conditioning will be handled by J. F. Naylor and Co., Baton Rouge. Contractors will begin work in January and completion is scheduled for the early part of 1959.

Eight separate laboratory sections, a pilot plant wing for experimenting and testing, conference rooms, attendant areas and office space will be contained within nearly 30,000 square feet of floor space.

One of the features of the building will be the addition of a spectroscopy laboratory to present facilities. It will be used to determine individual components of gas samples through the use of a mass spectrometer.

Continental Oil Co. has announced completion of a $1.5 million modernization project at its Wichita Falls, Texas, refinery, which includes a 3500-bpd catalytic reforming unit.

In addition to gasolines, products from the Conoco refinery include heating oils, diesel fuels, residual fuel oil and propane. The plant has a daily crude capacity of 9500 barrels.

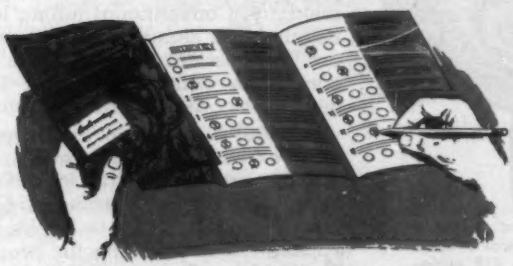
Pacific Cooperatives, wholesale supply organization for 125 farmer co-ops in Oregon, Washington and Idaho, is considering building a 10,000 to 15,000 bpd refinery at Vancouver, Wash. Decision will be made by mid-January following completion of an economic feasibility study.

Crude for refinery could come either by pipe line from Alberta to Vancouver, B. C., and thence by barge to Vancouver, Washington, or by tanker from Middle East and Venezuela.

Now ! ! !
Be Sure to Read PETROLEUM REFINER'S Exclusive Report on Alkylation with "Construction Boxscore" Starting on Page 233

Stop explosions before they blow

Send for the CROUSE-HINDS "Hazard Finder"



● The Hazard Finder will enable you to make a quick survey of the hidden probabilities of electrically-ignited explosions in your plant.

Let Crouse-Hinds equipment and technical assistance help you to prevent electrically-ignited explosions.

The more than 15,000 Condulet ® items in the Crouse-Hinds line, include the world's widest selection of explosion-proof and dust-tight electrical equipment. There are Condulet devices for every circuitry requirement, and for every hazardous area and condition. All backed by engineers and technicians thoroughly familiar with Article 500 of the National Electrical Code and its application to specific situations.

For a quick, general survey of probable dangers in your plant, send for the Hazard Finder. For technical discussion of specific areas and hazards, write for Crouse-Hinds bulletins which apply.

• Or for personal assistance, ask any of the offices listed below to send a Field Engineer.

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● CONDULET® ELECTRICAL EQUIPMENT (Explosion-Proof and Conventional) ● FLOODLIGHTING
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These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Baton Rouge Birmingham Boston Buffalo Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Philadelphia Pittsburgh Portland, Ore. Salt Lake City St. Louis St. Paul San Francisco Seattle Tulsa Washington **Resident Representatives:** Albany Atlanta Baltimore Charlotte Chattanooga Jacksonville Reading, Pa. Richmond, Va. Shreveport

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Syracuse 1, N. Y.

I want to check my plant. Send me your Hazard Finder.

Name_____

Company_____ Title_____

Address_____

City_____ State_____

NEW! direct tank-mounted LIQUID LEVEL TRANSMITTER

Exclusive static pressure connection for closed vessels above or below atmosphere . . . eliminates need for second instrument.

This sensing diaphragm capsule flange-mounts directly on side of tank. All wetted parts of Type 316 stainless steel, with optional plastic coating for further corrosion protection.

with DIRECT 3-15 psi air output signal

IDEAL FOR: Viscous or corrosive fluids, slurries, and solids-in-suspension, as well as "easy-to-measure" fluids.

Now you can measure the level of "difficult" or easy-to-measure fluids — economically, without the complication of floats or bubble tubes, and with *sustained high accuracy over the entire range span.*

Flange-mounted directly to the side of an open or closed tank, the Type 13FA Transmitter eliminates piping and purging. Its stainless steel diaphragm capsule senses level changes instantly. Conventional tubing leads its output air signal directly to standard 3-15 psi receiver-recorders and controllers without need for intermediate signal converters.

The 13FA provides an accurate, trouble-free solution for level measurement problems. Write for detailed information, or ask your nearby Foxboro Field Engineer to explain its application to your specific process. **The Foxboro Company, 741 Norfolk St., Foxboro, Mass., U.S.A.**

FOXBORO

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LIQUID LEVEL TRANSMITTERS

"Construction Boxscore" data reveal . . .

Alkylation is Swinging to Motor Fuel

Once used only to make avgas, alkylate is now spurred-on as a motor fuel component. Here is the story on present and future alkylation growth.

Clayton A. Umbach, Jr.
Petroleum Refiner Staff

THE RESULTS of PETROLEUM REFINER's research into the correlation between the octane increases and the construction of new reforming capacity in different parts of the country was published with "Construction Boxscore" last October. Judging from the response, we believe you will also welcome this article which examines construction being done on another refining process—alkylation.

Here, we have considered construction of alkylation only for gasoline production, even though it also is used in production of petrochemicals such as ethylene and benzene alkylation for synthetic rubber.

Each quarter we make a complete survey in which more than 350 different oil companies and engineering and construction firms are contacted to develop fully a world wide picture for the refining-petrochemical-natural gasoline industry. The tabulation following this story is the result of our latest survey. You should find it useful in developing any type of study concerning construction in our field.

Alkylation Picture. During 1957, the alkylation capacity in this country was increased by 33,000 bpd. As each individual alkylation unit was announced and completed it was reported in the "Construction Boxscore."

At the beginning of 1957 the estimated alkylation capacity of the United States was about 280,000 barrels daily. With the added 33,000-bpd, the total for the start of 1958 stands at about 313,000 bpd. This amounts to a ten percent increase in a one year period.

Comparison with Crude Capacity. Now, how does alkylation construction stack-up against other types of construction? A comparison of alkylation with crude running capacity shows alkylation growing relatively faster.

United States refineries at the beginning of 1957 had a crude running capacity of 8.8 million bpd. The alkylation capacity at that time corresponded to 3.2 percent of the total crude capacity. During the last year, crude capacity increased to 9.1 million bpd, but alkylation grew even faster so that now it stands at 3.5 percent of the crude capacity.

Avgas Needs. The major portion of today's alkylation capacity was installed as a result of the aviation gasoline demands created by World War II. And of course, all of the alkylate available was committed to the production of avgas. Now that jet flight assumes the dominant role in the military air force, and commercial jet transportation is just over the horizon, the market for aviation gasoline will level off and perhaps even dip slightly.

To insure this nation of a potential supply of aviation gasoline, the government, until just recently, was granting fast tax write-offs for additional alkylation units.

Octane Characteristics. The continued growth of alkylation in spite of the leveling-off of the avgas market means one thing—more alkylate is being made available for motor fuel. The process applied to motor fuel production results in a product which has very good stability and high octanes.

Alkylation is second only to reforming as a means of getting those economical-as-possible F-1 octane levels. Nevertheless, the question still arises as to why we should use alkylation at all; the octane numbers are much higher with reforming.

Unlike reforming, however, which

DAILY CAPACITIES FOR U.S.

	Crude*	Alkylation	
	(Thousand Barrels)	(Thousand Barrels)	(Percent of Crude)
Jan. 1957	8,800	280	3.2
Jan. 1958 (est.)	9,100	313	3.5

* Calculated from API "Statistical Bulletins."

has a 8-12 sensitivity, alkylate has an extremely low sensitivity; possibly one which is as negative as minus two. Therefore, while the alkylate will only have an F-1 octane rating of about 103 at 3 cc TEL per gallon, its outstanding characteristic gives it a relatively high leaded F-2 rating of about 104. This quality is desirable in that it compensates partially for the high sensitivity imparted to a gasoline blend by reformed and cracked components.

Road Ratings. Actually, road rating is the one true criterion for determining octane quality. Since road octane is influenced by both F-1 and F-2 rating, there have been new and renewed interests in these F-2 ratings of motor fuels. As the compression ratios get higher, the engines have a greater tendency to knock at high speeds. The F-2 rating of a fuel is a measure of its ability to satisfy those high-speed octane cravings. It is only natural, therefore, that refiners desire a gasoline component like alkylate.

It is difficult to define alkylation as an octane-improving process since it does not use gasoline type materials as a feed-stock. It combines an isobutane with a light or gaseous olefin to form a very stable material boiling in the gasoline range. Many refiners now consider it more desirable to devert olefins to alkylation instead of the more conventional polymerization processes. At least one refinery is isomerizing normal butane and then cracking to produce a butane feed for alkylation.

HOW OCTANES COMPARE*

Method	Rating with 3cc TEL/gal Reformate	Alkylate
F-1 Octane	103	103
F-2 Octane	94	104
Modified Borderline		
2000 RPM	103	108
3600 RPM	103	106
Modified Uniontown	103	107

*Estimated from data presented by Greytak, Bellah, and Morris, "Road Octane Numbers of Tomorrow's Gasolines in Tomorrow's Cars," before the Refining Division of the American Petroleum Institute in Philadelphia, May 14, 1957.

In the Future. The 45,000 bpd of alkylation already announced for 1958 and later exceeds that which was completed last year. With the leap-frogging in this country between higher octane gasolines and higher compression engines, we can see no let-up in the addition of alkylation capacity.

Construction BOXSCORE

REFINERIES, NATURAL GASOLINE AND PETROCHEMICAL PLANTS

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
Allied Chemical & Dye	Linden, N.J.	Sulfur Recovery	60 tons	.....	Complete	.....	.....	Girdler	Girdler
	Buffalo, N.Y.	*Polyethylene Compound	27,000,000 lbs.	.....	.....	Mid 1958	.....	.....	.....
American Cyanamid..	Santa Rosa County, Florida	Acrylic Fiber	yr.	.....	Under Constr.	1958	.....	.....	.....
American Oil Co.....	Yorktown, Va.	Gas Treating Sulphur Recovery	50 tons	.....	Engineering	.....	.....	Fluor	Fluor
California Oil Co.....	Perth Amboy, N.J.	Splitting Tower & Offsite Facilities	.....	.....	.....	.....	.....	Foster Wheeler	.....
		*Cat. Reformer	10,000 bbls.	.....	Engineering	Early 1959	.....	.....	.....
Chemstrand.....	Decatur, Ala.	Exp. Acrilan Plt.	45,000,000 lbs./yr.	.....	Under Constr.	1st Qtr., 1958	.....	Staff	Daniel Constr.
	Pensacola	Exp. Nylon Plt.	114,000,000 lbs./yr.	.....	Under Constr.	2nd Qtr., 1958	.....	Staff	.....
Cities Service.....	Linden, N.J.	Refinery Modernisation	.....	.....	Planning	1958	.....	.....	.....
		Asphalt Plt.	.....	.....	.....	1958	.....	.....	.....

* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 237

Electronic Computer speeds McKee engineering of your new plant

THE obvious advantage to you of McKee's IBM 650 Computer is elimination of the time-consuming labor of working out long and complicated formulae. This can now be done faster and at lower cost by our "electronic brain." But there's more to it than that.

This new tool, in the competent hands of McKee engineers, will process data quickly to provide accurate solution of engineering design problems; solve many intricate equations simultaneously; expedite selection of ***economic optimum*** design conditions; permit comparison of various combinations of processes and designs to arrive at the ***most economically attractive*** combination for correct design of your plant.

The 650 Computer will not, of course, replace engineering brains, experience and judgement. We'll continue to use those for constructive thinking—the kind of constructive thinking you'll want in the design and construction of your new plant.

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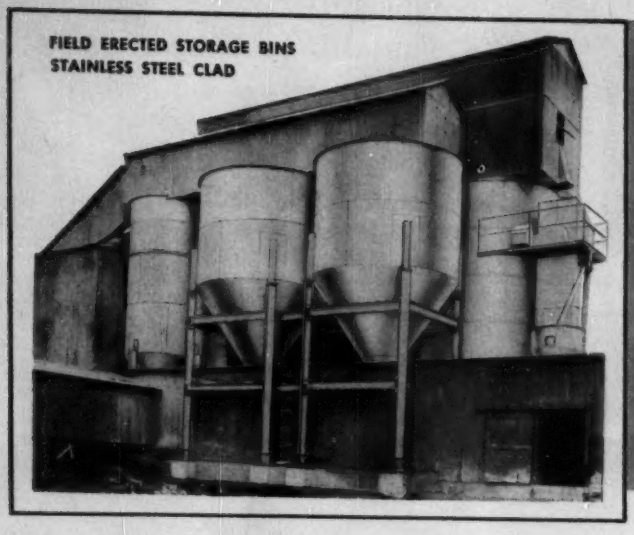
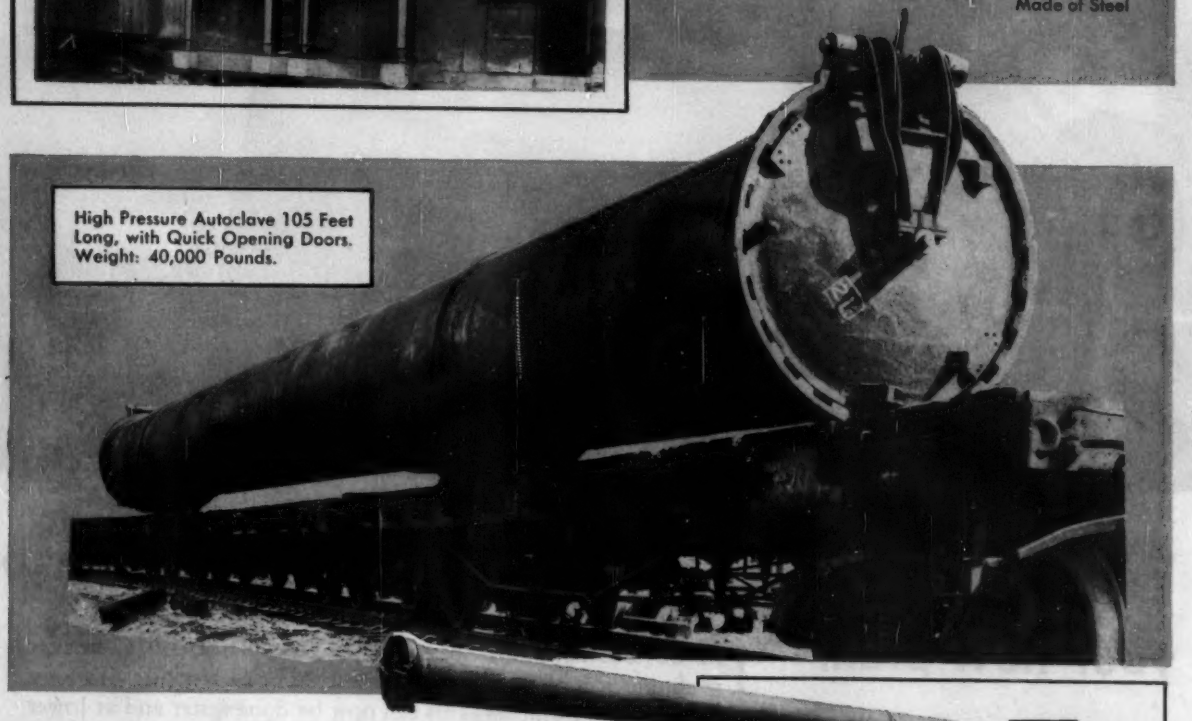
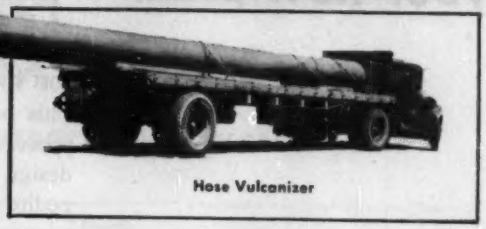


FIELD ERECTED STORAGE BINS
STAINLESS STEEL CLAD

Acid Tank
Made of Steel



High Pressure Autoclave 105 Feet Long, with Quick Opening Doors. Weight: 40,000 Pounds.



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CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Columbia Gas	Siloam, Ky.	Hydrocarbon Fractionation Plt.						Pritchard	Pritchard
Commerce Oil Ref.	Jamestown, R.I.	Refinery,	40,000 bbls.	$50,000,000	Under Constr.	Mid 1959	UOP	Fluor	Fluor
		Cat. Cracking	25,000 bbls.						
		Crude Units	40,000 bbls.						
du Pont	Belle Works, W. Va.	Urea; Ammonia Methyl Methacrylate, Nylon Intermediates			Planned	1959	Texaco		
Escambia Chemical	Pensacola, Fla.	Methanol	18,000,000 gal./yr.		Under Constr.	March, 1958		Chemico; Badger Mfg.	
Esso Standard	Linden, N.J.	Ethylene Plt.			Complete			S&W	S&W
	Bayway	Alkylation	10,700 bbls.	$8,000,000	Complete		Esso	Parsons	Parsons
		Hydrofiner	15,000 bbls.					Foster Wheeler	Foster Wheeler
Food Machinery & Chemical Corp.	S. Charleston, W.Va.	Exp. Carbon Tetrachloride Plt.			Engineering	Mid 1958		Staff, Fluor	Fluor
Frontier Refining	Buffalo, New York	Aromatics Plts.	45,000 gal.	$2,500,000 and $1,250,000 offsite facilities	Under Constr.	2nd Qtr., 1958	UOP	UOP	Procon
General Aniline & Film	Linden, N.J.	Ethylene Oxide: Ethylene Glycol		$8,000,000	Complete		Scientific Design	Scientific Design	Scientific Design
Goodrich Chemical Co.	Calvert City, Ky.	Acrylic Polymers		$2,500,000	Complete				Wigton-Abbott
Gulf Oil	Philadelphia	Cat. Reformer I	26,000 bbls.		Complete		UOP	Procon	Procon
		Cat. Reformer II	26,000 bbls.		Complete		UOP	Procon	Procon
	Near Charleston, S.C.	Refinery			Considering				
Hercules Powder	Parlin, N.J.	Polyethylene	30,000,000 lbs./yr.	$10,000,000	Under Constr.				
Koppers	Woodbridge, N.J.	Polyethylene	30,000,000 lbs./yr.		Under Constr.		Koppers	Koppers	Koppers
	Kobuta, Pa.	Polystyrene			Under Constr.	Early, 1958		Staff	Staff
Paragon Oil Co.	Tiverton, R.I.	Refinery	30,000 bbls.	$35,000,000	Planning				
Pennsalt	Calvert City, Ky.	Organic-Fluorine			Under Constr.			Staff	Miller & Johnson
Rhode Island Ref.	Tiverton, R.I.				Planning				
Sinclair Refining	Marcus Hook, Pa.	Gasoline Fractionation	10,000 bbls.		Under Constr.	Early, 1958		Fluor	Fluor
Socony Mobil	Buffalo, N.Y.	Alkylation	2,440 bbls.		Engineering			Kellogg	Kellogg
	Paulsboro, N.J.	*Delayed Coker	19,000 bbls.		Engineering	Early 1959			Lummus
Spencer Chemical	Henderson, Ky.	Urea Plt.	100 tons		Planning	Summer 1958	Montica-tinni	Staff	Quaker Valley
The Southland Co.	Black Point, Fla.	Refinery	15,000 bbls.	$12,000,000	Planning				
Standard-Indiana	Mandan, N.D.	Alkylation Unit	1,630 bbls.		Under Constr.	Sept., 1958	Phillips	Foster Wheeler	Foster Wheeler
Sunshine States Refineries	East Tampa, Fla.	Refinery	20,000 bbls.	$27,000,000	Under Design	1959		Kaiser	Kaiser
Union Carbide Chemicals	Institute, W.V.	Exp. Acrylonitrile Plt.				2nd Qtr., 1958			
	Winfield, W.V.	Petrochemical Plt.			Planning	1960			
United Fuel Gas Co.	Kenova, W.V.	Hydrocarbon Extraction Plt.		$8,000,000	Engineering	Dec., 1958		Pritchard	Pritchard
U.S. Rubber	Naugatuck, Conn.	Exp. Synthetic Rubber Plt.	35%		Complete				
		Exp. Organic Chemicals Plt.	†15 %						
MID-CONTINENT									
Amoco Chemical Corp.	Joliet, Ill.	Phthalic Anhydride Isophthalic Acid, Terephthalic Acid, Diemthyl Terephthalate, Dimethyl Isophthalate Benzoic Acid	60,000,000 lbs./yr.	$10,000,000	Under Constr.	1958		Scientific Design	Scientific Design Plants
Anderson-Prichard	Arkansas City, Kans.	Vacuum Tower	15,000 bbls.	$1,200,000	Engineering			Blaw-Knox	Blaw-Knox
	Cyril, Okla.	*Alkylation Unit	2,400 bbls.		Engineering	Late 1958	UOP	UOP; Treco	Treco
Bay Refining Corp.	Bay City, Mich.	*Crude Unit	12,000 bbls.	$900,000	Engineering	Summer 1958		Sweco	Sweco
Ben Franklin Refining	Ardmore, Okla.	HF Alkylation	1,000 bbls.	$800,000	Complete		UOP	Treco	Treco
Callery Chemical	Muskogee, Okla.	Hydrogen Plt.	800,000 scf						
		Nitrogen Plt.	200,000 scf		Engineering	3rd Qtr., 1958		Girdler	Girdler
		Carbon Dioxide	7,790 lbs./hr.						
Champlin Oil & Ref.	Enid, Okla.	HF Alky Unit	1,430 bbls.	$1,900,000	Engineering	March, 1958	Phillips	Badger Mfg.	Badger Mfg.
Clark Oil & Ref.	Chicago	Refinery Expansion	9,000 bbls.	$5,000,000					
		Vacuum Unit						UOP	CB&I; Morrison
		Alkylation				March, 1958	UOP	Dushell	Morrison
		Gas Recovery				March, 1958	UOP	UOP; Procon	Procon
		Cat Cracker				March, 1958	UOP	UOP; Procon	Procon
Coastal Chemical Corp.	Pascagoula, Miss.	Phosphoric Acid & Ammonium Phosphate	350 tons	$1,900,000	Complete		St. Gobain	Fluor	Fluor
		Sulfuric Acid Plt.	600 tons	$1,350,000	Complete		Titlestad	Titlestad	M. T. Reed
		Offsite Facilities		$2,500,000	Complete			Staff	
Cooperative Refinery Asso.	Phillipsburg, Kans.	Unifiner	3,500 bbls.	$1,500,000	Under Constr.	Early, 1958	UOP	Sweco	Sweco
		Platformer	2,500 bbls.						
	Coffeyville, Kans.	HF Alkylation Unit	1,100 bbls.	$1,500,000	Under Constr.	Summer, 1958	UOP	Treco	Treco
Dow Chemical	Bay City, Mich.	Ethylene Plt.			Under Constr.	1959			
		Gas Purification			Under Constr.			Girdler	Austin
du Pont	Ecorse, Mich.	Sulfuric Acid Plt.			Under Constr.	Early 1958		Staff	Staff
D-X Sunray	Duncan, Okla.	Unifining	6,000 bbls.		Under Constr.		UOP	Treco	Treco
	Tulsa	Unifining	20,000 bbls.						
		HF Alkylation	2,500 bbls.	$10,000,000	Under Constr.	Early 1958	UOP	Treco	Treco
		Butane-isomerization	2,500 bbls.						
		Platformer, Rerun Tower & LPG Recovery Unit	12,000 bbls.						
Ethyl Corp.	Joliet, Ill.	Antiknock Compounds			Planned				
Hawthorne Chemical Co.	Louisiana, Mo.	Methacrylate Plt.	35,000,000 lbs./yr.	$11,000,000	Engineering				
Kerr McGee	Wynnewood, Okla.	Platformer	5,500 bbls.	$4,500,000	Under Constr.	Spring 1958	UOP	UOP, Nofsinger	Treco
		Dist. Unifiner	4,000 bbls.						
Leonard Refineries	Alma, Mich.	FCC Unit	7,500 bbls.	$2,600,000	Engineering	Aug., 1958	UOP	Staff; Parsons	Parsons
		*Alkylation Unit	1,000 bbls.	$1,000,000	Engineering	1958	UOP	Parsons	Parsons

* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 238

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Lion Oil	El Dorado, Ark.	*Cat. Reformer	5,000 bbls.		Engineering	Late 1958			
Mississippi Chemical Corp.	Yazoo City, Miss.	Add Nitric Acid Plt.	150 tons	$1,500,000	Under Constr.	Feb., 1958		C & I	C & I
Monsanto Chemical	Monsanto, Ill.	Phenol Plt. Exp.	25 percent						
	El Dorado, Ark.	*Urea Plt.				Fall 1958			
National Petro-Chemical	Tuscola, Ill.	*Polyethylene Compounding	25,000,000 lbs./yr.		Engineering	Late 1958			
Northwestern Ref. Co.	St. Paul Park, Minn.	Cat. Reformer	6,000 bbls.	$2,500,000	Planning	Jan., 1959			
Olin Mathieson	Mapleton, Ill.	Antifreeze Plt.		$1,500,000	Under Constr.	Spring, 1958			P. S. Edwards Company
Pana Refining	Pana, Ill.	*Platformer Unifiner	1,500 bbls.		Engineering	3rd Qtr., 1958	UOP	UOP	
Petroleum Specialties	Flat Rock, Mich.	Visbreaker	3,000 bbls.	$250,000	Planning			Litwin	
Phillips Petroleum	Kansas City, Kans.	*Asphalt Exp.	1,100 bbls.		Engineering	Spring 1958		Staff	
Preston Oil Co.	Siloam, Ky.	Hydrocarbon Fractionation & Storage Plt.		$1,714,000	Under Constr.	Dec., 1958		Pritchard	Pritchard
Prime Oil Co.	Calumet City, Ill.	Refinery	15,000 bbls.	$10,000,000	Planned				
The Pure Oil Co.	Lemont, Ill.	Cat. Reformer	12,000 bbls.		Complete			Tellepsen	Tellepsen
		Feed Prep. Unit	17,000 bbls.						
		*Odorless Naphtha			Under Constr.	1958		Staff	Tellepsen
		*Revamp Gas Recovery Unit			Under Constr.	1958		Staff	Tellepsen
		*Polymerization Unit			Under Constr.	1958		Staff	Tellepsen
		*Revamp Crude Distill.			Under Constr.	1958		Staff	Tellepsen
		*Revamp Girbitol Unit			Under Constr.	1958		Staff	Tellepsen
Reichhold Chemicals	Tuscaloosa	Formaldehyde Plt.	35,000,000 lbs./yr.		Planning		Staff	Staff	Staff
	Detroit	Formaldehyde Plt.	35,000,000 lbs./yr.		Planning		Staff	Staff	Staff
Shell Oil	Wood River, Ill.	Effluent Treat. Facl.		$1,000,000	Complete				
Signal Oil & Gas	Healdton, Okla.	*Absorption		$250,000		March, 1958		Hudson	Hudson
	Tioga, N.D.	*Absorption		$200,000		July, 1958		Hammond Tank	Hammond Tank
Sinclair Oil & Gas	Garfield City, Okla.	Deisobutanizer	20,000 gals.		Under Constr.	Jan., 1958			
Sinclair Refining	East Chicago	MEK Deoiling	1,000 bbls.		Engineering	Fall 1958	Texaco	Badger Mfg.	Badger Mfg.
		Gaso. Fractionation	18,000 bbls.		Under Constr.	Early, 1958		Fluor	Fluor
Skelly Oil Co.	El Dorado, Kan.	HF Alkylation	3,000 to 4,000 b/s.		Engineering	Early, 1958	Phillips	Staff	Staff
	Medicine Lodge, Kans.	Exp. Natural Gaso. Plt.	40,000 gals.		Under Constr.	Jan., 1958		Staff	
Socony Mobil	East St. Louis	Sovaformer	12,000 bbls.		Planning			Fluor	Fluor
		Pretreater	16,000 bbls.		Planning			Fluor	Fluor
	Trenton, Mich.	Alkylation Unit	3,500 bbls.	$3,500,000	Engineering	Early, 1958		Fluor	Fluor
Standard-Indiana	Whiting, Ind.	Ultraformer II	21,000 bbls.		Complete	1957	Std (Ind.)	McKee	McKee
		*Crude Distillation Unit	140,000 bbls.		Engineering	1959			McKee
		*Ultraformer III	21,000 bbls.		Under Constr.	Mid 1958			Parsons
	Neodesha, Kans.	Ultraformer	6,000 bbls.		Under Constr.	Early 1958	Std. (Ind.)	Foster Wheeler	Foster Wheeler
	Wood River, Ill.	Crude Unit	67,500 bbls.		Engineering	Early 1959			McKee
	Mandan, N.D.	HF Alkylation Unit	1,630 bbls.		Under Constr.	Sept., 1958	Phillips	Foster Wheeler	Foster Wheeler
Standard (Ohio)	Toledo, Ohio	Refinery Exp.	†60,000 bbls.	$40,000,000	Under Constr.	June, 1958		Kellogg	Kellogg
	Elmore, Okla.	Exp. Gasoline Plt.	8 Mmcfd	$350,000	Complete			Olsen	Olsen
	Cleveland, Ohio	Alkylation	3,000 bbls.	$3,400,000	Planning	May, 1958			McKee Co.
Sun Oil Co.	Toledo	Alkylation Plt. Exp.		$1,000,000	Under Constr.			Staff	Catalytic
The Texas Co.	Lockport, Ill.	Convert Hydroformer to Platformer	10,000 bbls.		Complete			UOP	Staff
		Ammonia Plt.	180 tons		Complete			Foster Wheeler, C&I	Foster Wheeler, C&I
Vickers Petroleum	Potwin, Kans.	Udex Unit	15,000,000 gal./yr.	$2,000,000	Under Constr.	1st Qtr., 1958	UOP	Procon	Procon
Warren Petroleum & Sunray	Forgan, Okla	Gasoline Plt.		$2,000,000	Engineering	Aug., 1958			
Westland Oil Co.	Williston, N.D.	Inc. Platformer	530 bbls.	$320,000	Under Constr.	April, 1958	UOP	UOP	Staff
SOUTHWEST									
Aluminum Co. of America	Port Lavaca, Texas*	Gas Processing Plt.	100 Mmscfd	$1,500,000	Complete			Pregle, Dukler & Crump	Staff
American Cyanamid	Fortier, La.	Acrylonitrile Plt.		$25,000,000	Under Constr.	1958			
American Oil	Texas City	Ultraformer & Desulfurization Unit	21,000 bbls.		Engineering	Early 1958		Parsons	Parsons
		*Heating Oil System			Engineering	1958		Tellepsen	Tellepsen
		*Two Stage Distill. Unit			Under Constr.	1958		Staff	Tellepsen
Anchor Gasoline Corp.	E. Krotz Springs, La.	Gasoline Plt.	25 Mmcf	$500,000	Complete		March Co.	Charlie Barry Co.	Jay Pierce
Atlantic Refining	Pt. Arthur, Texas	Alkylation Unit	2,100 bbls.		Under Constr.	Spring, 1958		Fluor	Fluor
	Crane, Texas	Gasoline Plt.	20.5 Mmcf		Complete			Delta	Delta
Atlas Processing	Shreveport, La.	Isomerization Unit	3,500 bbls.		Under Constr.	Early, 1958	UOP	UOP	Hudson
Calcasieu Chemical	Lake Charles	Ethylene Oxide; Ethylene Glycol	8,000,000 gal./yr.			Early, 1958	Shell		Lummus
Calumet Refining	Princeton, La.	Crude Oil Distill.	2,000 bbls.		Complete			Kellogg, Staff	Staff
Carbide & Carbon	Seadrift, Texas	Ethylene Oxide Exp.	To 200,000,000 lbs./yr.		Planning				
		Inc. Ethylene Glycol Cap.	To 65,000,000 lbs./yr.		Planning				
Celanese	Bishop, Texas	Plt. Exp.	25 percent		Complete				
	Pampa, Texas	Acrylate Ester Plt.	15,000,000 lbs./yr.		Complete				
Chemoil Corp.	New Orleans	Refinery	40,000 bbls.	$35,000,000	Design			Lummus	Lummus
Cities Service	Lake Charles, La.	Inc. Reforming Cap.			Planning				
		Ethylene Plt.	2,000,000 lbs./yr.						
		*Butane Isomerization			Under Constr.	1958		Tellepsen	Tellepsen
	Dora Roberts Ranch, Texas	Natural Gaso. Plt.			Under Constr.				
Consolidated Chemical, Ind.	Baytown	Sulfur Recovery Plt.			Complete			Parsons	Parsons

* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 241

Ohio FITTINGS and RETURN BENDS

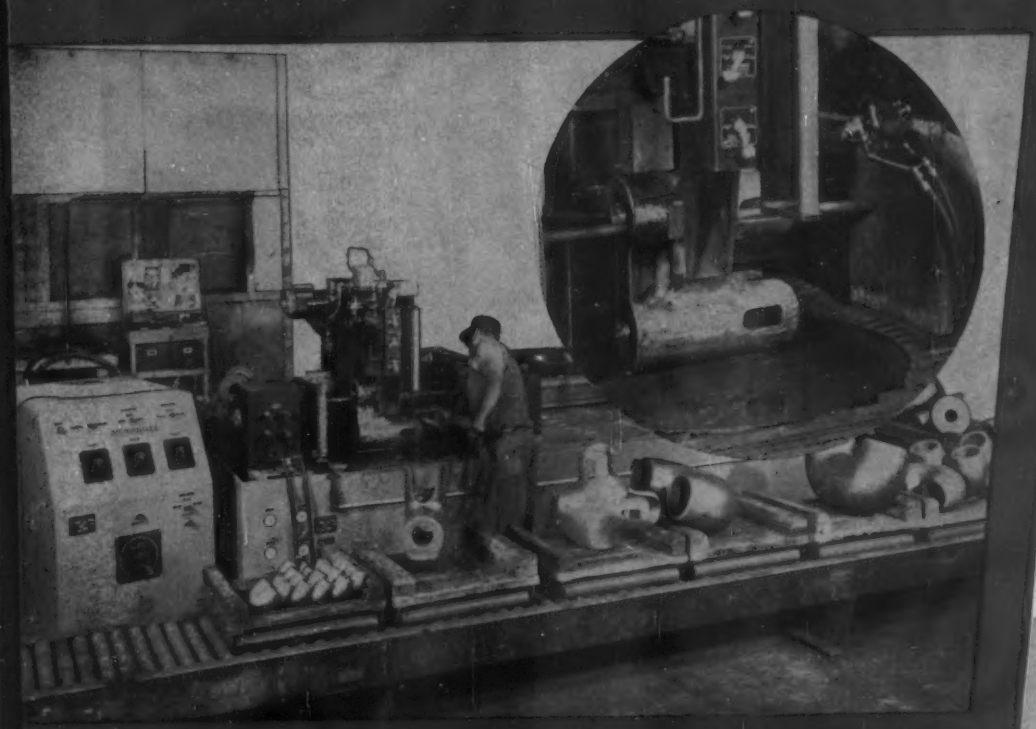
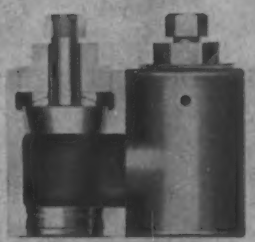


Photo shows operator surveying return bend in preparation for Magnaglo inspection

Magnaglo production surface inspection

Ohio Steel is the first steel foundry to install this special Magnaglo unit for quick and accurate surface inspection of Cast Return Bends and Fittings for the oil and chemical industries.

We invite you to witness this operation and see our other modern foundry and machining facilities.



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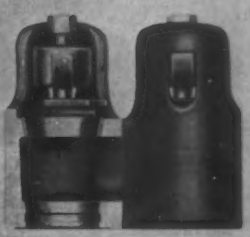

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Type 1001-W2

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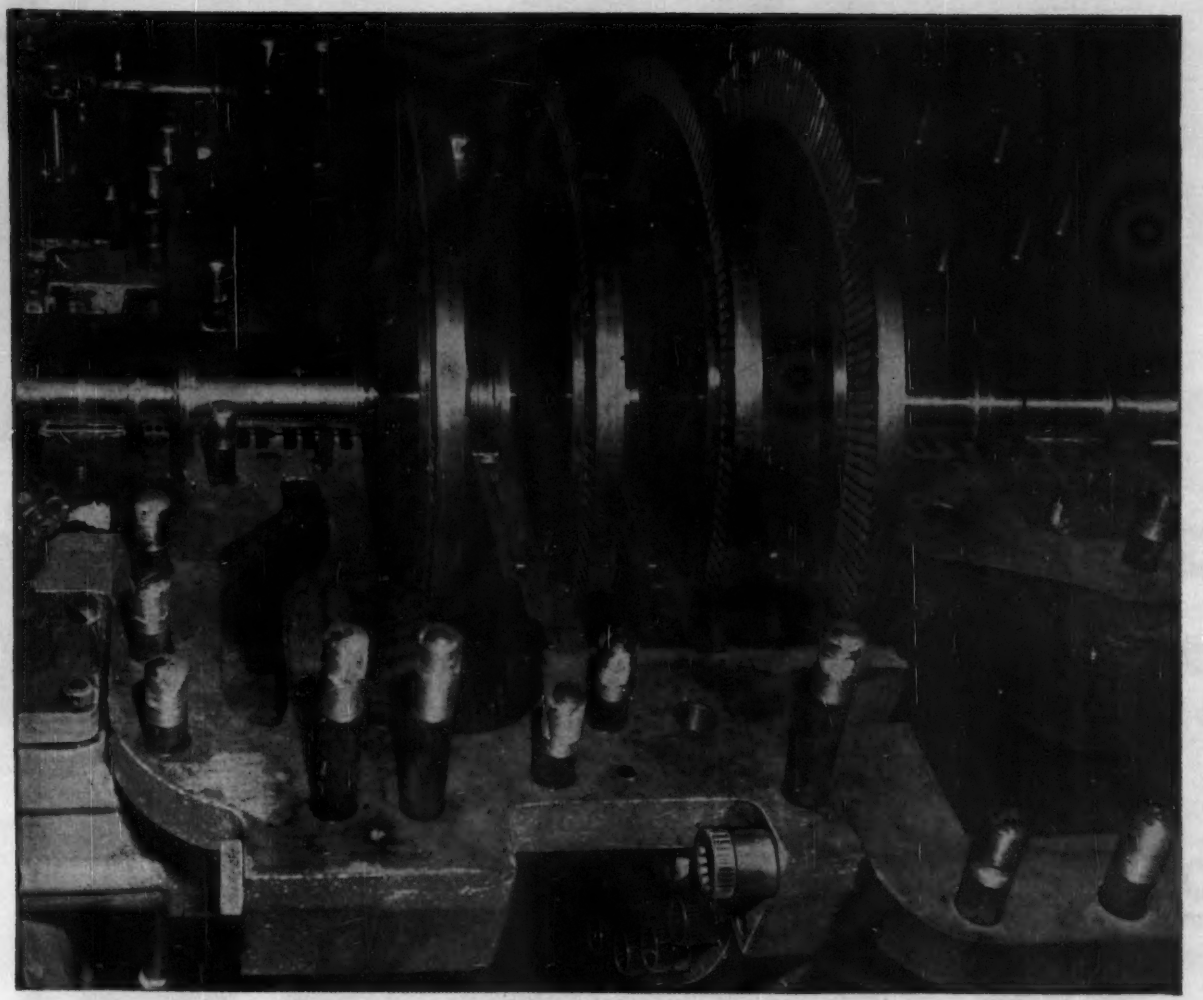
THE OHIO STEEL FOUNDRY CO.

SPRINGFIELD, OHIO

Plants at Springfield and Lima, Ohio



THE INSIDE STORY OF A MURRAY HIGH SPEED COMPRESSOR DRIVE TURBINE REVEALS THE REASONS FOR MURRAY'S UNIVERSAL ACCEPTANCE

A look at MURRAY'S rugged construction from the inside shows the husky shaft and heavy accurately formed discs with generous sized hubs designed to withstand the axial and radial stresses imposed by this type of service.

Large-dimension disc rims receive the specially contoured stainless steel blades with the Murray integral shroud. This insures smooth steam passages with maximum strength.

Short bearing spans insure smooth operation and eliminate the hazard of operating in critical speeds.

A look at the heavy flanges and husky bolting in the actual unretouched shop photo shown above bears out the extreme ruggedness that typifies every feature of Murray construction.

Our nearest representative will gladly help you solve your high speed compressor drive turbine requirements. Just write to Murray Iron Works Company, Burlington, Iowa for his name.

★ ★ **Murray Turbines** ★ ★

For more data on advertised products, use Readers' Service Cards, last page.

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Continental Oil	Wichita Falls, Texas	Cat. Reformer	3,500 bbls.	$1,450,000	Under Constr.	Early, 1958	.....	Treco	Treco
	Lake Charles, La.	Coking-Calcining Unit	10,000 bbls.	$6,250,000	Complete	.....	.....	Fluor	Fluor
	Gretna, La.	Exp. Petrochemical Plt.	.....	.....	Complete	.....	.....	.....	.....
Copolymer Rubber & Chemical	Baton Rouge	Plt. Exp. Butadiene	35,000 short tons yr.	.....	.....	.....	.....	.....	.....
Cosden Petroleum	Big Spring, Texas	*Polystyrene Plt.	.....	.....	.....	April, 1958	.....	.....	.....
Cotton Valley Operators	Cotton Valley, La.	*Ethylene Recovery Unit	.....	.....	.....	April, 1958	.....	.....	Delta
Diamond Alkali	Houston	Perchlorethylene Exp.	50 percent	.....	Under Constr.	.....	.....	.....	.....
		Acetylene Plt.	.....	.....	Engineering	.....	.....	.....	.....
	Deer Park	Vinyl Chloride Plt.	.....	$10,000,000	Engineering	Early, 1958	.....	Scientific Design	Brown & Root
Dorchester Corp.	White Deer, Texas	Cat. Reformer	1,000 bbls.	$700,000	Complete	.....	Atlantic	Grebe & Doremus	Staff
Dow Chemical	Plaquemine, La.	Ethylene and Propylene Glycols and Oxides, Chlorinated Solvents	.....	Part of $50,000,000	Under Constr.	1958	.....	.....	.....
	Freeport, Texas	Acetylene, Methylacetylene, Ethanolamines, Synthetic Glycerine, Butadiene, Chlorine, Ethylene Oxide, Methyl Chloride, Glycerine, Glycol, Perchloro EthyleneandStyrene Glycerine Plt.	.....	$45,000,000	Under Constr.	1958	.....	.....	.....
du Pont	Orange	Polyethylene	.....	.....	Under Constr.	1958	.....	.....	.....
	Near New Orleans	Petrochemical Plt.	.....	.....	Considering	.....	.....	.....	.....
El Paso Natural Gas Products	Victoria, Texas	Crude Hydrogen	.....	.....	Under Constr.	Feb., 1958	.....	Girdler	Staff
	Odessa, Texas	Refinery	6,500 bbls.	.....	Under Constr.	Early, 1958	UOP	Fish	Fish
		Alkylation Blending	.....	.....	Under Constr.	.....	.....	.....	.....
Esso Standard	Baton Rouge	Ethylene, Butadiene Expan.; Wax, Lube Oil, Avgas	.....	$40,000,000	.....	.....	.....	.....	.....
		Powerformer	25,000 bbls.	.....	Under Constr.	2nd Qtr., 1958	.....	Esso	Bechtel
		Alkylation	6,500 bbls.	.....	Designing	3rd Qtr., 1959	.....	Esso	.....
		LPG Storage	1,000,000 bbls.	.....	Under Constr.	1957	.....	.....	.....
		*Solvents Hydrofiner	3,600 bbls.	$75,000	Engineering	1958	Staff	Parsons	Parsons
		*Sulfuric Acid Alkylation	10,000 bbls.	.....	Under Constr.	Sept., 1958	.....	Foster Wheeler	Foster Wheeler
Ethyl Corp.	Baton Rouge	Vinyl-Chloride Monomer Pet.	.....	.....	Under Constr.	June, 1958	.....	Catalytic	Catalytic
Firestone	Orange	*Exp. Butadiene Plt.	20,000 tons/yr.	.....	Engineering	Summer 1958	.....	Catalytic	Catalytic
Grace & Co., Polymer Chemicals Div.	Baton Rouge, La.	Polyethylene	50,000,000 lbs./yr.	$18,000,000	Complete	.....	Phillips	Fluor	Fluor
Gulf Oil	Pt. Arthur, Texas	Greasemaking; Packaging	.....	.....	Under Constr.	July, 1958	.....	Sumner Sollitt	Sumner Sollitt
		Platformer	26,000 bbls.	.....	Under Constr.	Early 1958	UOP	Procon	Procon
		Gasoline Processing	10,000 bbls.	.....	Engineering	Late, 1958	UOP	Procon	Procon
		*Benzene Plt.	82,000 gals.	.....	Engineering	Early 1959	UOP	Procon	Procon
J. M. Huber	Borger, Texas	Furnace Black	20-30,000,000 lbs./yr.	.....	Planning	.....	.....	.....	.....
Humble	Baytown, Texas	FCC	51,200 bbls.	.....	Under Constr.	April, 1958	.....	Foster Wheeler	Foster Wheeler
		Benzene Plt.	30,000,000 gal./yr.	.....	Complete	.....	.....	Badger Mfg.	Badger Mfg.
		Ethylene Recovery Plt.	80,000,000 lbs./yr.	.....	Under Constr.	July, 1958	.....	Kellogg	Kellogg
		Hydrodesulfurization Unit I	43,200 bbls.	.....	Complete	.....	.....	Parsons	Parsons
		Hydrodesulfurization Unit II	43,200 bbls.	.....	Under Constr.	Jan., 1958	.....	Parsons	Parsons
		Butyl Exp.	13,000 tons/yr.	.....	Under Constr.	April, 1958	.....	Kidde Engrs.	Staff
		Varsol Hydrofining	6,000 bbls.	.....	Under Constr.	May, 1958	.....	Hudson	Hudson
		Phenol Lube Plt. No. 2	31,500 bbls.	.....	Engineering	Aug., 1958	.....	Kellogg	Brown & Root
		*Exp. Paraxylene Unit	9,000,000 lbs./yr.	.....	Engineering	Oct., 1958	.....	Staff	Staff
	Kleberg, County, Texas	Gas Process & Cycling Plt.	750 Mmcf	$75,000,000	Planning	Mid 1959	.....	.....	.....
	Fluor Bluff, Tex.	*Exp. Gasoline Plt.	.....	$4,000,000	Under Constr.	Early 1958	.....	Staff	Humble
Jefferson Chemical	Port Neches, Texas	Inc. Ethylene Cap. Inc. Ethylene Glycol Cap. Inc. of Ethylene Oxide Cap.	.....	.....	Engineering	Mid 1958	S&W	S&W	S&W
La Gloria Oil & Gas	Falfurrias, Texas	Exp. Gaso. Plt.	2,200 bbls.	.....	.....	.....	.....	.....	Hudson
Magnolia	Beaumont, Texas	Crude Distill.	100,000 bbls.	.....	Under Constr.	Mid 1958	.....	Foster Wheeler	Foster Wheeler
		Alkylation Unit	8,000 bbls.	.....	Under Constr.	Early 1958	.....	Staff, Braun	Braun
		Sulfur Recovery Unit	70 light tons	.....	Under Constr.	Early 1958	.....	Foster Wheeler	Foster Wheeler
		Sovaformer	30,000 bbls.	.....	Under Constr.	Late, 1958	.....	Staff, Foster Wheeler	Staff, Foster Wheeler
		Exp. LPG Fractionation	.....	.....	Under Constr.	Mid 1958	.....	Magnolia, Fluor	Fluor
McBride Refining Co.	Port Brownsville, Texas	Ref. Expan.	†2,500 bbls.	$2,500,000	Planned	.....	.....	.....	.....
Monsanto	Texas City	Exp. Acrylonitrile Plt.	100,000,000 lbs./yr.	.....	Under Constr.	Early 1958	.....	.....	.....
		Inc. Styrene Monomer Cap.	†40,000,000 lbs./yr.	.....	.....	June, 1958	.....	.....	.....
National Petro-Chemical	Houston	Polyethylene Plt.	75,000,000 lbs./yr.	.....	.....	Late, 1958	.....	Kellogg	Kellogg
Neches Butane Products	Port Neches, Texas	Butadiene Plt. Exp.	300,000 tons/yr.	.....	Under Constr.	Mid, 1958	.....	Foster Wheeler	Foster Wheeler
Northeast Texas Chemical Co.	East Texas	Chemical and Fertilizer Plt.	.....	.....	Planning	.....	.....	Tears	Beck
Odessa Styrene	Odessa, Texas	Styrene Plt.	40,000,000 lbs./yr.	$5,000,000	Engineering	Jan., 1958	UOP	Fish	Fish
Ohio Oil Company	Orange, Texas	Gasoline Plt.	10 Mmcf	$800,000	Complete	.....	.....	Olsen	Olsen
Petroleum Chemicals	Lake Charles	Anhydrous Ammonia	100,000 tons/yr.	$12,500,000	Under Constr.	Early 1958	.....	Foster Wheeler	Foster Wheeler
		Ethylene Plt.	20,000,000 lbs./yr.	.....	Under Constr.	Jan., 1958	.....	Lummus	Lummus
		Butyl Rubber Plt.	30,000 tons/yr.	$17,000,000	Engineering	Early 1959	.....	Foster Wheeler	Foster Wheeler

* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 242

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Phillips Chemical	Gulf Coast	Carbon Black	64,000,000 lbs./yr.		Planning				
Phillips Petroleum	Sweeny, Texas	Nat. Gas Liquid Fractionation	15,000 bbls.		Complete			Phillips	S&W
		Inc. Alkylation	2,000 bbls.		Complete			Phillips	Phillips
		Inc. Nat. Gas Liq.	20,000 bbls.		Complete			Phillips	S&W
		Cat. Reformer; Desulfurization	16,000 bbls.		Under Constr.	April, 1958		Phillips	Fluor
	Borger	*Pentane Isomerization	13,500 bbls.		Under Constr.	1st Qtr., 1958	UOP		
Reef Fields Gasoline Corp.	Howard County, Texas	*67 M M cfd			Under Constr.	Spring, 1958		Delta	Delta
Rohm & Haas	Houston	Acetylene			Complete		Texaco	Chemico	Chemico
		Methanol			Complete		Texaco	Foster Wheeler	Foster Wheeler
		Ammonia			Complete		Texaco	Foster Wheeler	Foster Wheeler
Shamrock Oil & Gas	Dumas, Texas	Inc. Crude Cap.;	20,000 bbls.		Complete			Staff	Staff
		Inc. Sulfuric Acid Alkylation	3,600 bbls.		Complete			Staff	Staff
		N-Butane Isomerization	2,000 bbls.		Complete		Phillips	Staff	Leonard Constr.
		Isobutane Cracking	1,500 bbls.		Complete		Phillips	Staff	Leonard Constr.
		Sludge Regen. and Contact	75 tons			Early 1958	Monsanto	Leonard Constr.	Leonard Constr.
		Sulfuric Acid Plt.	75 tons	$850,000	Under Constr.				
Shell Chemical	Norco, La.	Methyl Ethyl Ketone			Complete			Braun	Braun
Shell Oil	Norco	Cat. Gasoline Fractionator						Foster Wheeler	Foster Wheeler
		Platformer			Planning				
Sinclair Refining	Corpus Christi	Cat. Reformer	6,500 bbls.		Under Constr.	Spring 1958		Fluor	Fluor
		Gaso. Fractionation	5,400 bbls.		Under Constr.	Spring 1958		Fluor	Fluor
	Houston	Hydrodesulfurization	24,000 bbls.	$5,600,000	Complete			Parsons	Parsons
		Gaso. Fractionation	27,000 bbls.		Under Constr.	Early 1958		Fluor	Fluor
		*Udex Paraxylene		$6,000,000	Engineering	Early 1959	UOP	Badger Mfg.	Badger Mfg.
		*Steam Generating & Water Treating	250,000 lbs. hr.	$1,500,000	Engineering	Early 1959		Kidde Engrs.	Kidde Engrs.
	Hulldale Field, Texas	Desulfuriser			Under Constr.				
Spencer Chemical	Orange, Texas	Polyethylene Exp.	90,000,000 lbs./yr.		Under Constr.	Summer, 1958		Staff	Quaker
Standard-Texas	El Paso	FCC	27,000 bbls.		Complete		Esso	Fluor	Fluor
		Ref. Exp.	†25,000 bbls.		Complete		Esso	Staff, Fluor	Fluor
Suntide Refining	Corpus Christi	*Gas Recovery Unit	2,000 bbls.	$275,000		May, 1958	UOP	Staff	Staff
The Texas Co.	Port Arthur	Power Plt.			Under Constr.	1958		Jackson & Moreland	Texaco
		Crude Unit	86,000 bbls.		Under Constr.	3rd Qtr., 1958		Fluor	Fluor
		Cat. Cracker	60,000 bbls.		Under Constr.	3rd Qtr., 1958		Kellogg	Kellogg
		Inc. Alkylation	2,000 bbls.		Under Constr.	3rd Qtr., 1958		Staff	Staff
		Cat. Reformer	20,000 bbls.		Engineering	4th Qtr., 1958		UOP	
		Udex Unit	28,000 bbls.		Engineering	4th Qtr., 1958		UOP & Others	Staff & Others
Tidewater Oil	New Hope, Texas	Injection Plt.	15 Mmcf	$700,000	Under Constr.			Olsen	Olsen
United Rubber & Chemical	Baytown, Texas	*Synthetic Rubber Facil.			Under Constr.	1958		Day & Zimmerman	Tellepsen
U.S. Rubber	Baton Rouge, La.	Plastics		$5,000,000	Complete			Kidde Engrs.	
Wisco Gas Processing	Wise County, Texas	Gasoline Plt.	150 Mmcf	$4,000,000	Under Constr.	Early 1958		Olsen	Olsen
Wyandotte Chemical	Geismar, La.	Ethylene-Oxide Glycol	60,000,000 lbs./yr.	$8,000,000	Approved		Shell	Lummus	Lummus
ROCKY MOUNTAIN									
Apache Powder Co.	Curtiss, Ariz.	Ammonia Synthesis Plt.		$1,000,000	Under Constr.	Early 1958		Girdler	Staff
Bay Petroleum	Denver	Cat. Reformer	3,800 bbls.	$1,200,000	Under Constr.	Early 1958		Kellogg	Kellogg
Cabot Carbon	Lovington, N. M.	Gasoline Plt.	6 Mmcf	$1,000,000	Complete			Gas Plt. Constr.	
Carter Oil Co.	Billings, Mont.	*Increase Crude Cap.	34,500 bbls.		Under Constr.	May, 1958		Esso	Staff
El Paso Natural Gas Products Co.	Gallup, N.M.	Refinery; Alkylation, Cat. Reforming, Cat. Cracking, Vacuum Crude Unit	9,000 bbls.	$10,000,000	Under Constr.		UOP	Sweco	Sweco
	Bloomfield, N.M.	Natural Gasoline	165 Mmcf	$3,800,000	Under Constr.	Jan., 1958		Stearns-Roger	Stearns-Roger
Farmers Union Central Exchange	Laurel, Mont.	Naphtha Unifiner	4,400 bbls.		Under Constr.	Early 1958	UOP		Treco
		Platformer	5,100 bbls.						
		Distillate Unifiner	7,100 bbls.						
Frontier Refining	Cheyenne, Wyo.	Revamp Vac. Unit			Complete			Treco-Staff	Treco-Staff
Phillips Petroleum	Woods Cross, Utah	Cat. Reformer	3,700 bbls		Under Constr.	Spring, 1958		Procon	Procon
	Great Falls, Mont.	*Asphalt Exp.			Engineering	Spring 1958		Staff	
Salt Lake Refg.	Salt Lake City	Reformer	6,000 bbls.		Under Constr.				Fluor
Socony Mobil	Casper, Wyo.	Cat. Reforming	3,250 bbls.		Under Constr.			Pritchard	Pritchard
		Cat. Hydrodesulfurization	3,400 bbls.		Under Constr.			Pritchard	Pritchard
Southwestern Agro-chemical Corp.	Chandler, Ariz.	*Ammonia Synthesis Plt.	60 tons	$5,000,000	Planning	June, 1959			
Standard-Indiana	Casper, Wyo.	Lube Oil Plt.	5,000 bbls.						
		Vacuum Pipe Still	4,800 bbls.						
		Propane Deasphtg.	1,000 bbls.		Complete			Foster Wheeler	Foster Wheeler
		Furfural Extraction	1,500 bbls.						
		MEK Dewaxing, Deoiling	2,000 bbls.				Texaco Texaco		
Tennessee Gas	Lea County, N.M.	Gas Process Plt.	10 Mmcf	$2,000,000	Under Constr.	Early 1958		O. L. Olsen	O. L. Olsen
The Texas Co.	San Juan County, Utah	Gasoline Plt.							
Utah Oil Refining	Salt Lake City	CO Boiler for FCU		$970,000	Under Constr.	March, 1958		Stearns-Roger	Stearns-Roger
		Crude Unit	35,000 bbls.	$2,000,000	Under Constr.	June, 1958		Fluor	Fluor
WEST COAST									
Cal-Mex Oil & Refining	San Diego	Refinery	20,000 bbls.		Engineering	Early 1959		Parsons	Parsons
Douglas Oil	Bakersfield	Unifiner	1,300 bbls.		Complete	1959	UOP	Macco	Macco
		*Depropanizer Unit	12,000 bbls.		Engineering		UOP	Macco	
	Los Angeles	Topping Plt.	12,000 bbls.		Engineering	1959		Sweco	

* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 245

You say you have a temperature problem?

If things are getting too hot for you, get in touch with National Tube. We *specialize* in solving temperature problems—and pressure, oxidation, acid and corrosion problems, too. As a matter of fact—as if you hadn't guessed—we make our living by solving *all* types of refinery tubing problems.

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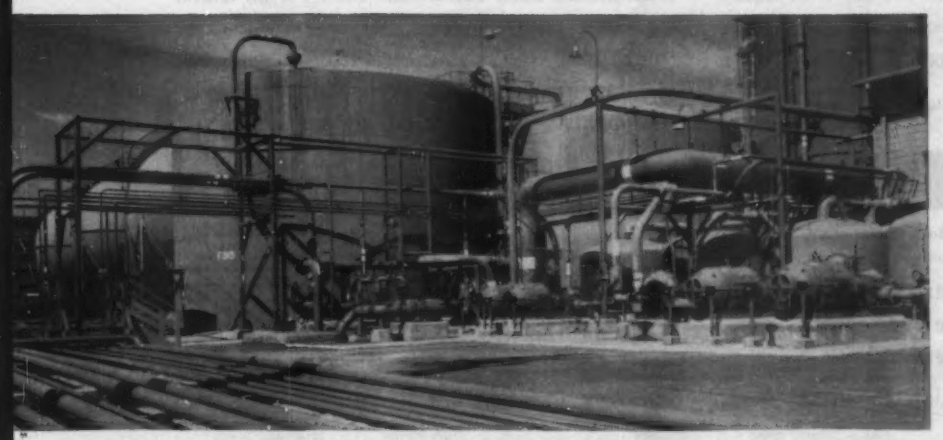
Get in touch with us. Our Mill Service Force, available for field consultation, will help you find just the alloy you need, at the right price, to meet your refinery conditions. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

HERE ARE NATIONAL TUBE'S TWO DOZEN DIFFERENT TUBE ANALYSES:

Carbon	5 Cr, ½ Mo	17 Cr
Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8
1 Cr, ½ Mo	7 Cr, ½ Mo	18-8 Ti
1¼ Cr, ½ Mo	8 Cr, ½ Mo	18-8 Cb
2 Cr, ½ Mo	8 Cr, 1 Mo	18-8 Mo
2¼ Cr, 1 Mo	9 Cr, 1 Mo	25-20
2½ Cr, ½ Mo, ¾ Si	12 Cr	3½ Ni
3 Cr, 1 Mo	12 Cr, Al	5 Ni



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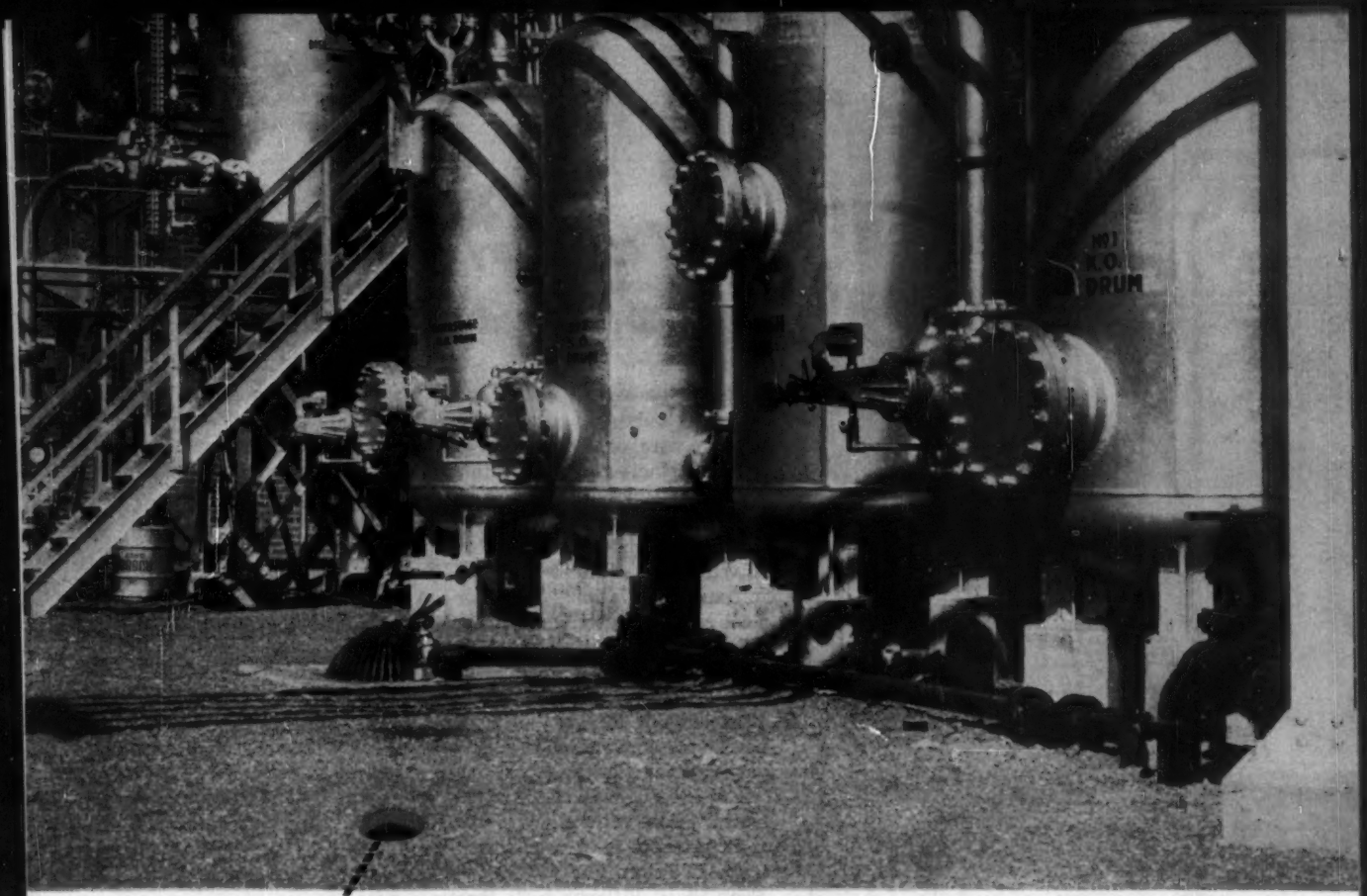

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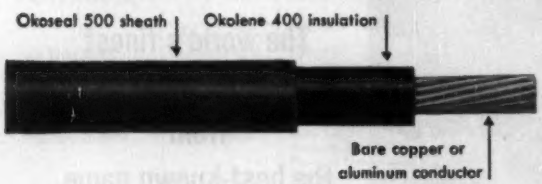
never take cathodic protection for granted

Cathodic protection is no more effective than the cable that carries the protective current. And factors that materially shorten the life of ordinary cable are especially prevalent around petroleum refineries and petrochemical plants. Your own soil may reveal many destructive agents such as petroleum oils, paraffinic hydrocarbons, mineral acids, alkalies and esters.



Okonite Cathodic Protection Cable has been especially engineered for optimum chemical and mechanical protection in direct burial installations where such conditions occur. This cable, insulated with Okolene 400 (a polyethylene compound) and sheathed with Okoseal 500 (a polyvinyl chloride compound), has been thoroughly tested in the lab and service-proved in the field.

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***where there's electrical power... there's* OKONITE CABLE**

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
du Pont	Antioch, Calif.	Fluorinated Hydrocarbons, Tetraethyl Lead			Under Constr.				
Ethyl Corp.	San Francisco	Anti-knock Compound Mfg. Plt.				Mid 1958		Braun	Braun
Fletcher Oil	Wilmington, California	Unifiner Platformer			Under Constr.	Spring, 1958	UOP	Parsons	Parsons
General Petroleum	Ferndale, Wash.	Cat. Reformer	9,000 bbls.		Complete			Socony, Bechtel	Bechtel
	Torrance, Calif.	Cat. Reformer	12,000 bbls.		Complete			Staff-Parsons	Parsons
Golden Bear Oil Co.	Oildale, Calif.	Revamp Furfural Treating Unit		$100,000	Complete		Texaco	Staff-D.G. Reynolds	
Hercules Powder	Hercules, Calif.	*Urea Plt.	60 tons		Engineering		Vulcan-Inventa	Vulcan	Vulcan
Reichhold Chemicals	South San Francisco	Plasticizers			Complete			Staff	Staff
Richfield Oil	Everett, Wash.	Refinery	50,000 bbls.		Planning				
	Los Angeles	Benzene Plt.	18,000,000 gal./yr.		Under Constr.	May, 1958			
Shell Chemical	Domingues, Calif.	Exp. Isopropyl Alcohol Facl.			Under Constr.	Fall 1958			
Shell Oil	Anacortes, Wash.	Alkylation Unit			Engineering	Mid 1958		Fluor	Fluor
	Wilmington	Boiler for Cat. Cracker	200,000 lbs.	$1,000,000	Under Constr.				
		Platformer	16,000 bbls.			Early 1958		Kaiser	Kaiser
		*Crude De-Salting Unit	70,000 bbls.	$850,000	Engineering	Early 1958		Macco	Staff
Standard Oil (Calif.)	Everett, Wash.	Refinery	60,000 bbls.	$75,000,000	Planning	1961		Staff	
	Bakersfield	Cat. Reformer	5,000 bbls.	$4,500,000	Under Constr.	Mid 1958		Staff-Bechtel	Bechtel
	Richmond	Cat. Reformer	20,000 bbls.	$11,000,000	Under Constr.	Mid 1958		Staff-Bechtel	Bechtel
		Paraxylene Plt.			Under Constr.	Early 1958		Staff-Bechtel	Resendahl Corp.
	El Segundo	Deisobutaniser	†300 bbls.	$1,500,000	Under Constr.	1958		Staff	Macco
The Texas Co.	Anacortes, Wash.	Refinery	40,000 bbls.		Under Constr.	Jan., 1959		Bechtel	Bechtel
	Los Angeles	Udex Unit	9,000 bbls.		Engineering	4th Qtr., 1958		UOP	
Tidewater	Avon, Calif.	Platinum Cat. Reformer	22,500 bbls.		Under Constr.	March, 1958	Houdry	Bechtel	Bechtel
		Steam Generating Plt.	50,000 lbs./hr.			3rd Qtr., 1958		Bechtel	Bechtel
U.S. Oil & Refining	Tacoma, Wash.	Refinery	15,000 lbs.		Under Constr.	1958	UOP	J. B. Gill	J. B. Gill
OUTSIDE U.S.A.									
Alaska & Hawaii									
Alaska-Yukon Refiners	Haines	Refinery	7,500 bbls.	$6,000,000	Engineering	1958		Treco	Treco
Standard Oil (Calif.)	Honolulu	Refinery	35,000 bbls.	$40,000,000	Engineering	1959			
Canada									
British American Oil	Clarkson, Ont.	Offsite Facilities		$4,000,000				Fluor	Fluor
	Edmonton	Cat. Reformer	4,000 bbls.	2,900,000	Under Constr.	Early 1958		Lummus	Lummus
		Cat. Desulfurization	6,300 bbls.		Under Constr.	Early 1958	Atlantic	Lummus	Lummus
	Nevis, Alberta	*Gasoline Plt.	30,000 gals.						
	Pincher Creek	Sulfur Recovery	225 tons		Under Constr.			Parsons	Parsons
		*Gas Cycling	2,200 bbls.						
	Port Moody	Refinery	20,000 bbls.		Under Constr.	Late 1958		Kellogg	Kellogg
	Montreal	*Cat. Cr. Gaso. Splitter	12,000 bbls.	$750,000	Under Constr.	Early 1958		Procon	Procon
		*Cat. Ref. Gaso. Splitter	12,000 bbls.						
British Petroleum	Near Montreal	Refinery	30,000 bbls.	$30,000,000	Planning				
Canadian Husky Oil	Ft. William, Calgary	Refinery Exp.		$700,000	Under Constr.				
Canadian Oil Co., Ltd.	Corunna	*Crude Unit	20,000 bbls.	$3,000,000	Engineering	1959		Kellogg	Kellogg
Consumers, Cooperative Refinery, Ltd.	Regina, Sask.	*Coking Unit	3,000 bbls.	$1,300,000	Under Constr.	Late 1958		UOP; Staff	Fluor; Staff
Canadian Industries, Ltd.	Millhaven, Ont.	Anhydrous Ammonia	200 tons	$9,000,000	Complete				
	Edmonton, Alberta	Inc. Polythene	40,000,000 lbs./yr.		Under Constr.	1959			Poole Constr. Co., Ltd.
Canadian Petrofina	Montreal	Increase Cap.	30,000 bbls.	$3,000,000	Planning	2nd Half 1958			
Cities Service	Toronto	New Refinery	20,000 bbls.	$22,000,000	Engineering			Braun, Ltd.	Braun, Ltd.
Dow of Canada	Sarnia	Exp. Ethylene Plt.		$4,000,000	Complete			Staff	Canadian; Bechtel; Stearns-Roger
Excelsior Refineries	The Pas, Manitoba	Refinery	2-3,000 bbls.	$1,500,000	Planning				
Imperial Oil	Sarnia	Detergent Alkylate		$5,000,000	Complete			Fluor	Fluor
		Petrochemical Plt.		$28,500,000	Under Constr.	Summer 1958		Canadian Bechtel	Canadian Bechtel
	Ioco, B.C.	Powerformer Prefractionator, Hydrofiner	5,800 bbls.	$4,000,000	Under Constr.	Mid 1958	Esso	Canadian Bechtel	Canadian Bechtel
	Calgary	*Add Crude Cap.	14,700 bbls.						
		*Ca. Cracker	6,600 bbls.	$17,000,000	Engineering	Late 1959		Canadian Betchel; Staff	Canadian Betchel
		*Powerformer	8,700 bbls.						
		*Offsite Facilities							
	Winnipeg	Add. Crude Cap.	2,500 bbls.	$4,500,000					
		Powerformer	2,850 bbls.		Under Constr.	Early 1958			Foster Wheeler
		*Associated Facil.	1,100 bbls.						
Jefferson Lake Sulphur	Taylor Flats, B.C.	Sulfur Recovery Plt.	425 tons	$1,800,000	Complete			Parsons	Parsons
McColl-Frontenac	Montreal East	Hydrotreater	10,000 bbls.	$1,000,000	Under Constr.	Early 1958	Texas Co.	Foster Wheeler	Foster Wheeler, Ltd.
Midland Pet.	Stettler, Alta.	Crude Refinery	4,000 bbls.	$2,000,000	Under Constr.				
Pacific Petroleum, Ltd.	Dawson Creek	*Vacuum Distill. Unit		$350,000					
Pacific Petroleum & Phillips Petroleum	Taylor, B.C.	Refinery			Under Constr.	Early 1958		Stearns-Roger	Stearns-Roger
Royalite Oil	Kamloops, B.C.	Platformer	1,000 bbls.	$750,000	Under Constr.	March, 1958	UOP	UOP	Treco
Shell Oil (Canada)	Bronte, Ont.	Refinery			Considering				
	Montreal	HF Alkylation	1,500 bbls.	$4,000,000	Under Constr.	1958	UOP	UOP	Treco
								Treco, Staff	
	Montreal, East	*Exp. Asphalt Plt.		$450,000	Planning	1958		Staff	Staff
	Quebec	Tetramer Unit			Under Constr.	1958		Treco, Staff	Treco
		Resin Plt.		$1,000,000	Under Constr.	Early 1958		Treco, Staff	Treco
	Cochrane, Alberta	Exp. Treating Plt.			Under Constr.				
	Vancouver	*Solvent Plt.		$600,000	Under Constr.	1958		Fluor, Staff	Staff
Sherritt-Gordon Mines, Ltd.	Fort Saskatchewan, Alta.	Anhydrous Ammonia	75 tons	$24,000,000	Planned				
Union Carbide, Canada	Montreal East, Quebec	Ethylene Glycol & Polyethylene Exp.		$4,000,000	Under Constr.	Early 1958		Staff	

* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 246

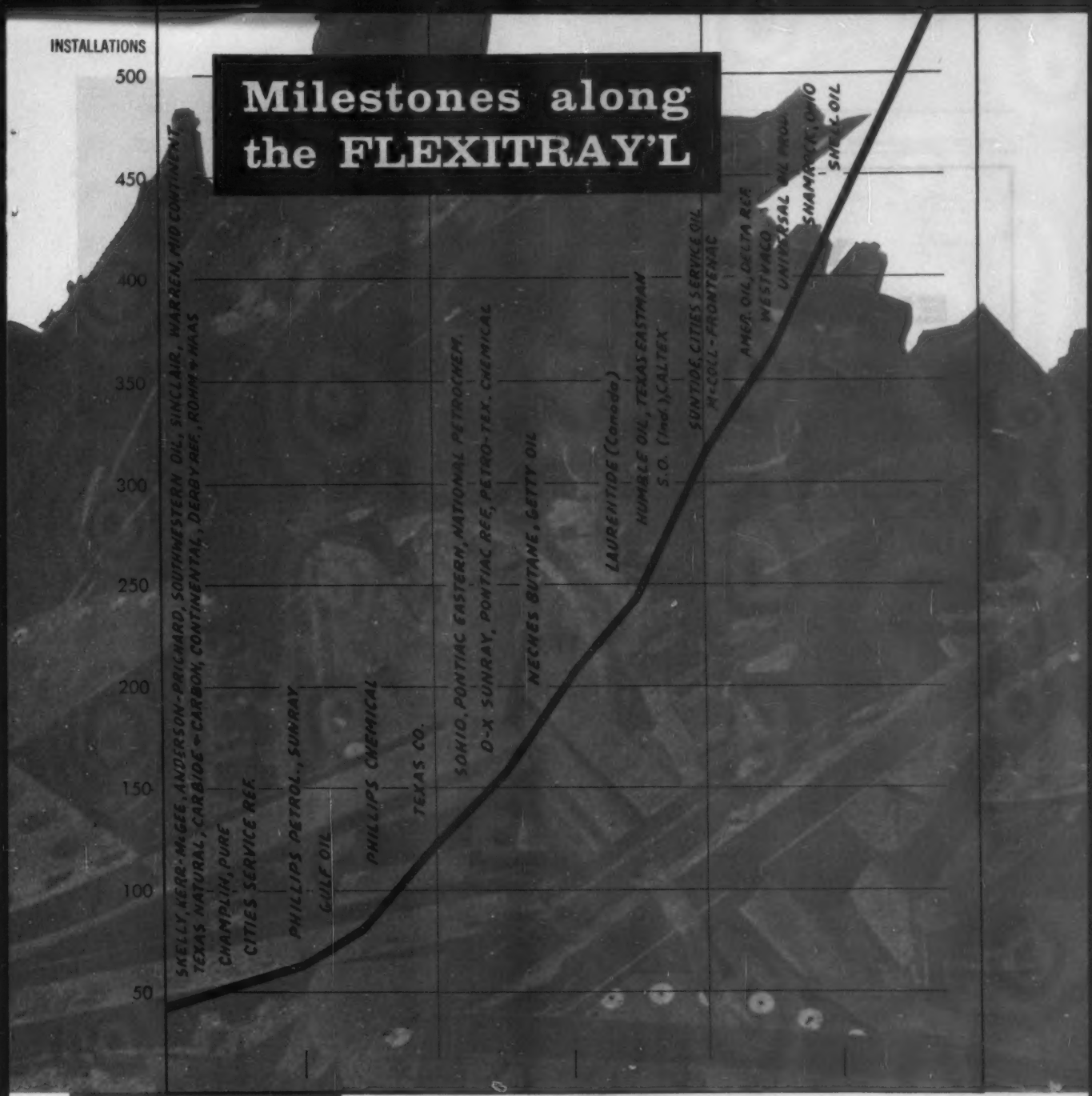
CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
LATIN AMERICA									
Brazil									
Alba (Borden)	Cubatao	Methanol, Formaldehyde, Synthetic Resins	30 tons	$3,500,000	Under Constr.	Mid 1958	Vulcan	Vulcan Girdler	Staff Girdler
Petroleo Brasileiro	North Brazil	Refinery	25,000 bbls.	.....	Studying	.....	.....	.....	.....
	South Brazil	Refinery	70,000 bbls.	.....	Studying	.....	.....	.....	.....
	Cubatao	Ethylene Recovery Unit	40,000,000 lbs./yr.	.....	Complete	.....	.....	Hydrocarbon, Edeleanu	Staff
	Mataripe	Atmospheric & Vacuum Distill. Units, Cat. Crkr., Gas Recovery, Wax Treating	37,000 bbls.	.....	Engineering	Mid 1959	Kellogg	Kellogg	Kellogg
	Rio de Janeiro	New Refinery	90,000 bbls.	$60,000,000	Engineering	Early 1960	.....	Foster Wheeler	.....
Uhde	Cubatao	Urea Plt.	.....	.....	.....	.....	.....	Uhde	Uhde
Union Carbide	Cubatao	Polyethylene	.....	.....	Under Constr.	Early 1958	.....	Brown & Root	Brown & Root Ltd.
Colombia									
Empresso Colombiana de Petroleos	El Centro	Plt. Modernization	2,000 bbls.	$3,000,000	Engineering	1958	.....	Parsons	Parsons
	Barranca Bermeja	Exp. Propane Recovery	1,000 bbls.	$1,000,000	Planning	.....	.....	.....	.....
International Petroleum (Colombia), Ltd.	Cartagena	Refinery	26,500 bbls.	$32,500,000	Complete	.....	Esso	Bechtel	Bechtel
Cuba									
Esso Standard	Havana	Ref. Expan.; Distillation, Polymerization, Powerforming, Cat. Cracking	To 35,000 bbls.	$30,000,000	Under Constr.	.....	Esso	McKee	McKee
Refinadora Cabaiguan	Cabaigun, Cuba	Ref. Expan.	.....	.....	Planning	.....	.....	.....	.....
The Texas Co.	Santiago	Refinery	20,000 bbls.	$14,000,000	Complete	.....	.....	.....	.....
Mexico									
Celanese Mexicana, S.A.	Mexico City	Formaldehyde; Synthetic Resin	.....	.....	Complete	.....	.....	.....	.....
Central Minera, S.A.	Tenixtepec, Mex.	Sulphur Plt.	1,000 tons	$3,500,000	Under Constr.	March, 1958	.....	.....	.....
Pemex	Mexico City	Cat. Cracking, Gas Concentration, HF Alkylation; Polymerization; Ethylene; Sulphur	25,000 bbls.	$12,500,000	Complete	.....	Esso-Phillips, UOP	McKee	Staff
	Ciudad Madero	Topping Cat. Cracking Gas Concentration; HF Alkylation; Polymerization; Sulfur Plt.	100,000 bbls. 25,000 bbls.	$25,700,000	Under Constr.	Mid 1958	Phillips, Esso, UOP	McKee	Staff
	Minatitlan	Combination Distill.; Clay Treating; Lube Oil	6,500 bbls.	$2,500,000	Complete	.....	.....	Fluor	Staff
	Salamanca	Grease Plt.	25 tons	$1,700,000	Engineering	.....	.....	McKee	Staff
		Cat. Cracker	15,000 bbls.	.....	Planning	.....	.....	.....	.....
	Poza Rica	Topping Plt.	10,000 bbls.	$1,350,000	Engineering	.....	.....	Staff	Staff
Netherlands Antilles									
N. V. Curacaosche Petro. Ind., Mij.	Curacao	Feed Prep. (2)	33,000 bbls. 33,000 bbls.	$7,000,000 $7,000,000	Complete	.....	.....	Badger Badger	Werkspoor, N.V. Werkspoor, N.V.
		Cat. Cracker	33,000 bbls.	.....	Complete	.....	.....	N.V. De Batasfsche Pet. Mij.	Werkspoor, N.V.
Panama									
Refiner a Petroquimica de Panama	Colon	Refinery	55,000 bbls.	$33,000,000	Engineering	.....	.....	Foster Wheeler	Foster Wheeler
Refineria Panama	Las Minas Bay, Cozon	Refinery; Petrochemicals	70,000 bbls.	$59,000,000	Under Constr.	1959	.....	Pet. Comb. & Eng. Co.	Pet. Comb. & Eng. Co.
Peru									
Helios, S.A.	San Andres	Fertilizer Plt.	130,000 tons	.....	Planning	.....	.....	.....	.....
Puerto Rico									
Commonwealth Oil Refining	Guayanilla Bay	*Refinery Exp.	75,000 bbls.	$9,500,000	Planning	Mid 1959	.....	.....	.....
Union Carbide Caribe	Ponce	Ethylene-Glycol	500,000 lbs.	$28,500,000	Planning	Mid 1958	.....	Brown & Root	Brown & Root
Trinidad									
W. R. Grace & Co.	Trinidad	Chemical Plt.	.....	$10,000,000	Planning	.....	.....	.....	.....
Uruguay									
Administracion Nacional de Combustibles Alcohol Y Portland	Montevideo	*Crude Distill.	28,000 bbls.	$12,000,000	Engineering	Late 1959	.....	Staff	Staff
		*Vac. Distill.	10,000 bbls.	.....	.....	.....	.....	.....	.....
		Cat. Cracker	5,000 bbls.	.....	.....	.....	.....	.....	.....
		*Cat. Reformer	3,000 bbls.	.....	.....	.....	.....	.....	.....
		*Gas Concent. & Bottling	.....	.....	.....	.....	.....	.....	.....
		*Gas Sweetening	4,500 bbls.	.....	.....	.....	.....	.....	.....
		*Sulfur Recovery	6 tons	.....	.....	.....	.....	.....	.....
		*Power Plt. & Offsite Facil.	3,600 KW	.....	.....	.....	.....	.....	.....
Venezuela									
Cia Shell de Venezuela	Cardon	Distillation	80,000 bbls.	$20,000,000	Under Constr.	3rd Qtr., 1958	.....	.....	.....
		Alkylation	2,300 bbls.	.....	Under Constr.	2nd Qtr., 1958	.....	.....	.....
Creole Pet. Corp.	Amuay Bay	Hydrofining Plt.	17,000 bbls.	$3,000,000	Under Constr.	.....	.....	Foster Wheler	Foster Wheeler
		Lube Oil Plt.	700 bbls.	$7,650,000	Under Constr.	May, 1958	Esso	Foster Wheeler	Foster Wheeler
	Lake Maracaibo	LPG Plt.	17,000 bbls.	$11,173,000	Under Constr.	1958	Creole	Tellepsen	Tellepsen
Venezuelan Govt.	Venezuela	Ammonia Synthesis Gas	120 tons	$1,000,000	Planning	.....	.....	Air Products	Air Products
EUROPE AND AFRICA									
Belgium									
Esso Belgium	Antwerp	Vac. Distill.	2,900 bbls.	$750,000	Engineering	Early 1958	.....	Badger-Comprimo	Badger-Comprimo
		Powerformer Hydrofiner	5,600 bbls. 6,900 bbls.	$7,100,000	Under Constr.	Early 1958	.....	Badger-Comprimo	Badger-Comprimo
Petrochim	Antwerp	Ethylene Oxide, Ethylene Glycol Desulfurization	.....	$8,000,000	Complete	.....	Scientific Design	Scientific Design	.....
Soc. Industrielle Belge de Petroles	Antwerp	Cat. Reformer	10,000 bbls.	.....	Under Constr.	April, 1958	UOP	Kellogg; UOP	Kellogg
		Hydrofiner	10,000 bbls.	.....	Under Constr.	April, 1958	.....	Kellogg	Kellogg
Denmark									
The Maersk Refinery	Copenhagen,	*Steam Cracker	3,500 bbls.	.....	Under Constr.	Spring 1958	.....	Foster Wheeler	Foster Wheeler

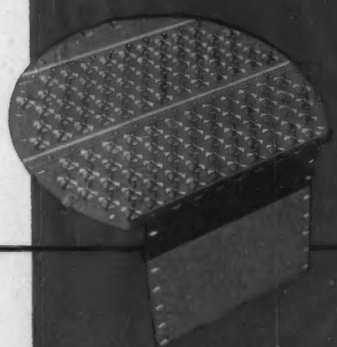
* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 249

Milestones along the FLEXITRAY'L



*Dates of original orders only, reorders not shown.



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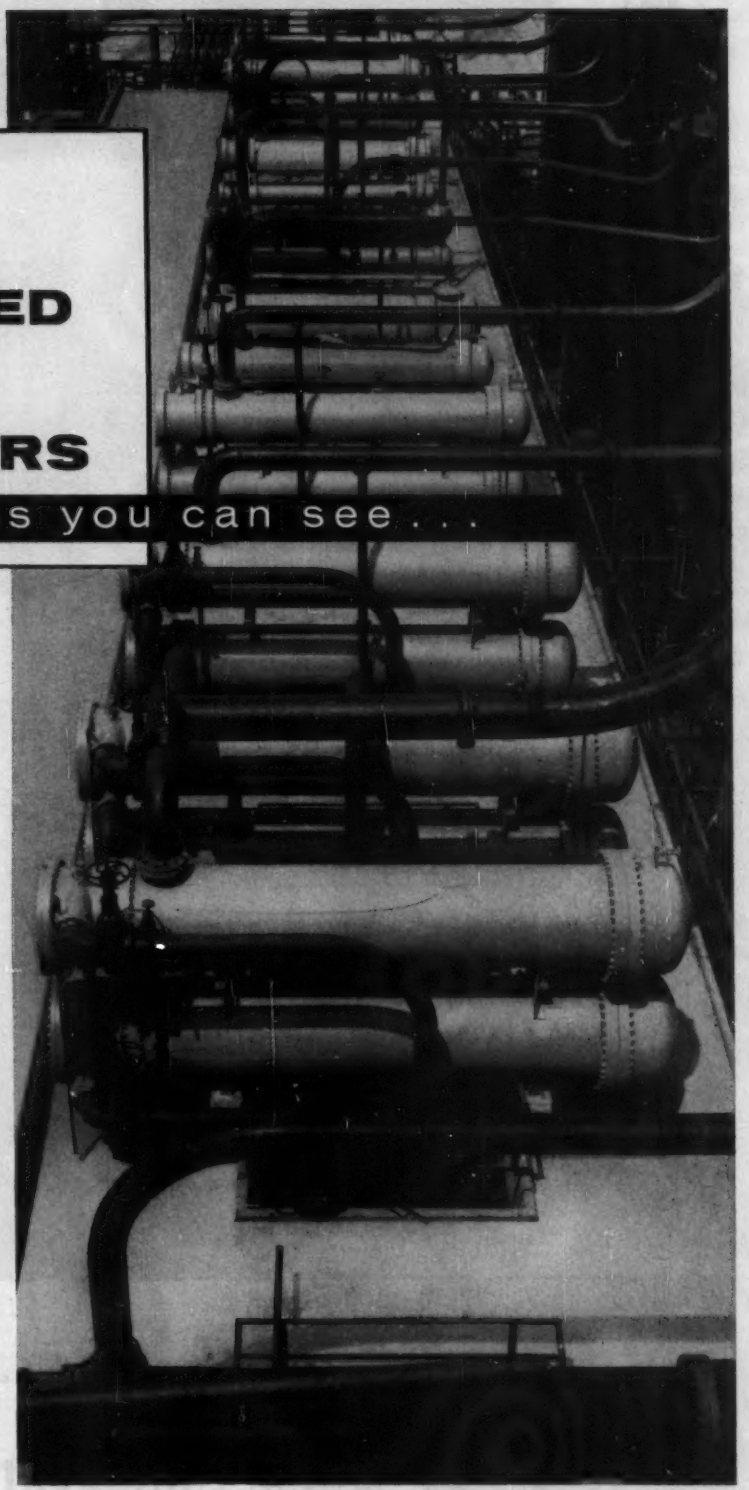

...and what you see is still only a fraction of the more than 100 heat exchangers giving trouble-free service in the high octane plant of the Continental Oil Co. at Ponca City, Okla. The Yuba units in this refinery have a total of 140,418 sq. ft. of heating surface.

Heat exchangers for petroleum refineries and for chemical plants can be built with Yuba's patented *Multilok Closure* to handle volatile fluids at 1200 F and pressures at 6000 psi and higher. Heat exchangers in lower pressure-temperature ranges, where leakage is not a problem, have standard bolted flange construction.

Yuba's ability to outfit a process or an entire plant with heat exchange equipment is one of its outstanding accomplishments. Yuba's design efficiency helps a petroleum or chemical plant to achieve maximum heat economy and, as a result, helps it to lower its manufacturing costs significantly.

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CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Egypt									
Anglo-Egyptian Oilfields	Suez	Cat. Reformer	2,300 bbls.	.....	Projected	.....	.....	.....	.....
Egyptian Govt.....	Suez	Power Plt.	10,000 KW.	$2,200,000	Planned	1959	.....	Italian Firms	
		Mech. Workshop	.....	$1,000,000	Under Constr.	Jan., 1958	.....	.....	Local
		Atmos. Dist., Vac. Dist. & Lube Oils	20,000 bbls.	$7,000,000	Planning	1960	.....	.....	.....
		Vapor Recovery & Bottling	70 tons	$1,000,000	Planned	1959	.....	Lummus	Lummus
	Alex	Atmos. & Vac. Dist.	10,000 bbls.	$1,400,000	Planning	.....	.....	.....	.....
	Cairo	Atmos. Dist. & Vac. Dist.	10,000 bbls.	$1,400,000	Planning	.....	.....	.....	.....
England									
British Petroleum....	Kent	Hydrofiner I	10,000 bbls.	.....	Complete	.....	.....	Kellogg	.....
		Hydrofiner II	10,000 bbls.	.....	Under Constr.	Mid 1958	.....	Kellogg	McAlpine, Wimpey
		Stabilizer	12,000 bbls.	.....	Complete	.....	.....	Power Gas Corp.	McAlpine, Wimpey
		Absorption and Regeneration Units	.....	.....	Complete	.....	.....	Kellogg	McAlpine, Wimpey
		Sulfur Recovery Plt.	45 tons	.....	Complete	.....	.....	Simon-Carves	McAlpine, Wimpey
		Two Copper Chloride Units	8,000 bbls., ea.	.....	Under Constr.	Early 1958	.....	W. J. Fraser	McAlpine, Wimpey
		Alkylation Plt.	2,250 bbls.	.....	Under Constr.	Early 1958	.....	Lummus	
		Distillation Unit	90,000 bbls.	.....	Complete	.....	.....	Badger, Ltd.	McAlpine,
		Cat. Reformer	10,000 bbls.	.....	Under Constr.	Early 1958	.....	UOP, Kellogg	Wimpey
		Thermal Reforming	12,000 bbls.	.....	Under Constr.	Mid 1958	.....	Kellogg	
		*Udex Unit	500 lbs.	.....	Engineering	1958	.....	UOP, Badger	McAlpine, Wimpey
Eastern Gas Board...	Dunstable	Oil Gasification	6,000,000 cu. ft.	.....	Planning	Spring 1958	.....	H & G	H & G
	Ponders End.	*Catalytic Oil Gasification	0 mm cfd	.....	Under Constr.	.....	.....	Power-Gas	Power-Gas
East Midland Gas Board	Sheffield	Oil Gasification	10,000,000 cu. ft.	.....	Complete	.....	.....	H & G	H & G
	Northampton	Oil Gasification	6,000,000 cu. ft.	.....	Planning	.....	.....	H & G	H & G
Esso Petroleum Co..	Fawley	Ethylene & Butadiene Plt.	.....	$27,000,000	Engineering	Mid 1958	.....	Foster Wheeler	Foster Wheeler
		Sulfur Plt.	60 tons	$700,000	Engineering	1st Qtr., 1958	.....	Foster Wheeler	Foster Wheeler
		Crude Pipestill	70,000 bbls.	$5,000,000	Under Constr.	.....	.....	Foster Wheeler	Foster Wheeler
	Milford Haven	Refinery	100,000 bbls. yr.	$56,000,000	Planning	Early 1960	.....	.....	.....
	Port Jerome	*Ethylene Plt.	.....	.....	.....	Mid 1959	.....	Foster Wheeler	Foster Wheeler
		*Gas Oil Hydrofiner	.....	.....	.....	Mid 1959	.....	Foster Wheeler	Foster Wheeler
Hedon Chemicals.....	Hedon, Yorks	Vinyl Acetate	.....	.....	Under Constr.	.....	.....	.....	.....
International Synthetic Rubber	Fawley	Synthetic Rubber	50,000 ton/yr.	$12,000,000	Engineering	.....	.....	Blaw Knox	Blaw Knox
Melta Gas Board.....	Valetta	*Catalytic Oil Gasification	1 Mmcfd	.....	Under Constr.	Early 1959	.....	Power-Gas	Power-Gas
Mobil Oil Co., Ltd...	Coryton	Cat. Hydrodesulfurisation	.....	.....	Pre-engineering	.....	.....	.....	.....
		Crude Unit Exp.	5,000 bbls.	.....	Under Constr.	1st Qtr., 1958	.....	Staff	Staff
Monsanto Chemicals..	Britain	Add Polystyrene	.....	.....	Under Constr.	.....	.....	Staff	Staff
		Styrene-Butadiene Copolymer Plt.	4,000 ton/yr.	$14,000,000	Planned	.....	.....	.....	.....
		Refinery Tail Gas Reforming	36,000,000 cu. ft.	.....	Under Constr.	March, 1958	.....	H & G	H & G
Petrochemicals, Ltd..	Partington, Nr. Manchester	*Exp. Ethylene Plt.	30,000 tons/yr.	.....	Engineering	.....	.....	H.W.P.	H.W.P.
Shell Chemical.....	Shell Haven	Ammonia; Nitric Acid	75,000 tons/yr.	$18,500,000	Planning	1958	.....	.....	.....
		Fertilizer	.....	$12,500,000	Planning	.....	.....	.....	.....
	Partington	Ethylene Oxide	25,000 tons/yr.	.....	.....	Mid 1958	.....	.....	.....
Shell Refining.....	Shell Haven	Atmospheric Distil.	80,000 bbls.	.....	Under Constr.	Late 1958	.....	S&W; E. B. Badger, Ltd.	E. B. Badger, Ltd.
		Hydrodesulfuriser	16,000 bbls.	.....	Projected	1960	.....	.....	.....
South Eastern Gas Board	Isle of Grain	Oil Gasification	15 Mmcf	.....	Under Constr.	Fall 1958	.....	Power Gas	Power Gas
		Segas Cat. Oil-Gas Unit	20,000,000 CF	.....	.....	1958	.....	Power Gas	.....
Southern Gas Board..	Southampton	Refinery Tail Gas Reforming	16 Mmcf	.....	Under Constr.	Oct., 1958	.....	H & G	H & G
	Reading	*Catalytic Oil Gasification	7 mm cfd	.....	Under Constr.	Early 1959	.....	Power-Gas	Power-Gas
France									
Cabot France S.A....	Berre-L'Etang	Carbon-Black Plt.	150,000 lbs.	$4,000,000	Complete	.....	Cabot	Staff	CITRA
Caltex S. A. F.....	Ambes	Cat. Cracker	4,700 bbls.	.....	Complete	.....	.....	Lummus	Lummus
		Vacuum Unit	6,600 bbls.	.....	Complete	.....	.....	Lummus	Lummus
Compagnie de Raffinage Shell Berre	Petit Couronne	Distl. Unit	80,000 bbls.	.....	Under Constr.	3rd Qtr., 1958	.....	.....	.....
		*Hydrodesulfurizer	11,000 bbls.	.....	Projected	3rd Qtr., 1959	.....	.....	.....
Comp Francaise de Raffinage	Provence	Powerformer	20,000 bbls.	.....	Under Constr.	Mid 1958	.....	Foster Wheeler	Foster Wheeler
	Normandie	Ethylene Plt.	30,000 tons/yr.	.....	Engineering	1958	.....	KIC	.....
Esso Standard.....	Gironde Bordeaux	Refinery	31,500 bbls. Expandable to 45,000 bbls.	.....	Planning	1959	Esso	Lummus	Lummus
	Port Jerome	Cat. Cracker	10,000 bbls.	$11,000,000	Complete	.....	.....	Foster Wheeler	Foster Wheeler
		Powerformer	.....	.....	Under Constr.	2nd Qtr., 1958	Esso	Foster Wheeler	Foster Wheeler
Houilleres du Bassin de Lorraine	Carling	Acetylene Plt.	.....	.....	Under Constr.	.....	Koppers	SBA	SBA
		Styrene Monomer	.....	.....	Under Constr.	.....	.....	SBA	SBA
Lorraine-Kuhlman....	Dieuze (Moselle)	Polystyrolene	.....	.....	Under Constr.	.....	Koppers	Kuhlman	.....
Manufacture Normande de Polyethylene	Gonfreville	Polyethylene	.....	.....	Under Constr.	.....	Phillips	.....	S.T.E.C.
Marles-Kuhlmann....	Gonfreville	Ethylene Oxide	.....	.....	Under Constr.	.....	Scientific Design	Staff	.....
Mobil Oil Francaise..	Gravenchon	Lube Exp.	.....	.....	Complete 1st phase Engineering 2nd phase	1958	.....	.....	.....
					Planning 3rd phase	1959			
Naphtachimie.....	Lavera	Exp. Ethylene Oxide	.....	.....	Complete	.....	Scientific Design	Scientific Design	.....
		Expand Ethylene	.....	.....	Complete	.....	.....	S&W, E. B. Badger, Ltd.	.....
Potasse et Engrais Chimiques	Grand Couronne	Ammonia	.....	.....	.....	.....	SBA	KIC	KIC
Shell-Berre.....	Berre	Furfural Unit	3,500 bbls.	.....	.....	.....	.....	Foster Wheeler	Foster Wheeler

* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 250

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Societe du Caoutchouc Butyl	Port Jerome	Butyl Rubber Plt.	20,000 tons/yr.	.....	Under Constr.	Fall 1958	Esso	Braun	Braun
Soc. Francaise des Petroles BP	Dunkirk	Cat. Reformer	10,000 bbls.	.....	Under Constr.	Early 1958	.....	UOP; Kellogg	.....
	Lavera	Distillation	50,000 bbls.	.....	Under Constr.	.....	.....	Foster Wheeler	Foster Wheeler
Soc. Nationale des Petroles D'Aquitaine	Lacq	Desulfurization	†140 Mmcf	.....	Under Constr.	Mid 1958	.....	Foster Wheeler	Foster Wheeler
		Distill. Recovery with Prod. Treat, & Fract.	†90 Mmcf	.....	Engineering	Mid 1958	.....	Hydrocarbon	Hydrocarbon
		Sulfur Recovery	†780 tons	$22,000,000	.....	.....	.....	Parsons & Heurtey; Soc. Chimique de la Grande Pavaisse	Soc. Chimique de la Grande Pavaisse
		*Sulfur Recovery Phase II	1,720 tons	.....	Under Constr.	1958	Parsons	Parsons, Heurtey, Soc. Chimique de la Grande Pavaisse	Parsons, Heurtey, Soc. Chimique de la Grande Pavaisse
		*Sulfur Recovery Phase III	.....	.....	Engineering	1959	.....		
East Germany									
Ministry of Coal & Energy	Rostock	*Catalytic Oil Gasification	2.4 mm cfd	.....	Under Constr.	End 1958	.....	Power-Gas; Didier	Power-Gas; Didier
West Germany									
Badische Anilin und Soda Fabrik A G	Ludwigshafen	Polyethylene	.....	.....	Licensed	.....	Phillips	.....	.....
Buna Werke Huls G.m.b.H.	Marl, Kreis Recklinghausen	Synthetic Rubber Plt.	45,000 tons/yr.	$37,000,000	Under Constr.	Summer 1958	Esso; R&E Houdry; Firestone	Staff	Staff
Deutsche Erdol	Heide/Holstein	Propane-Propylene Separation	.....	.....	Under Constr.	.....	Calif. Res. Hydrocarbon	Hydrocarbon, Hydro M	Staff
Deutsche Shell	Harburg	Cat Reformer Crude Distiller Cat. Reformer Hydrodesulfurisation	40,000 bbls.	.....	Projected	1st Qtr., 1959	.....	.....	.....
	Godorf	Refinery	80,000 bbls.	.....	Planning	1960	.....	.....	.....
Esso A. G.	Cologne	Refinery	72,000 bbls.	$39,000,000	Engineering	Jan., 1959	Esso		Braun & Others
		Atmospheric Crude Distill.	.....	.....	.....	.....	.....	Braun, Uhde, Lurgi	.....
		Powerformer	9,000 bbls.	.....	.....	.....	.....	G.H.H.	.....
		Gas-Oil Hydrofiner	12,000 bbls.	.....	.....	.....	.....	Kocks Still	.....
		Steam Cracker	5,600 bbls.	.....	.....	.....	.....		.....
		Sulfur Recovery	8,900 tons/yr.	.....	.....	.....	.....		.....
Farbenfabriken Bayer A. G.	Dormagen	Crude Oil Cracking Plt.	.....	.....	.....	Fall 1958	Lurgi	.....	.....
		Ethylene Oxide	26 MM lbs./yr.	.....	Under Constr.	1958	Scientific Design	Scientific Design	.....
Feldmuhle	Lulsdorf	Ethylene	10,000 tons/yr.	.....	Engineering	End 1958	.....	Hydrocarbon Hydro M	Hydro M
Kohle-Oil Chemie	Gelsenkirchen	Polyethylene	24,000 tons/yr.	.....	Planning	.....	.....	.....	.....
Mobil Oil A. G.	Bremen Osiebhausen	Crude Two Stage	16,000 bbls.	.....	Under Constr.	2nd Qtr., 1958	.....	Hydrocarbon Hydro M	Hydro M
Purfina Mineralolraffinerie A. G.	Duisburg	Topping, Platformer Hydrodesulfuriser	20,000 bbls.	.....	Under Constr.	Mar., 1959	UOP, Shell	Lummus	Lummus
Rheinische Olefinwerke	Bes. Koln Wesseling	Exp. Polyethylene Plt.	.....	$33,000,000	.....	Late 1958	BASF	.....	.....
Ruhrbau	Mulheim	Refinery	15,000 bbls.	.....	Planning	.....	.....	.....	.....
Ireland									
Irish Refining Co Esso Petr. (Ireland) Caltex (Ireland) Shell Mex., B.P.	Whitegate	Refinery	32,000 bbls.	$33,600,000	Approved	1959	.....	.....	.....
Italy									
Azienda Nazionale Idrogenazione Combustibil	Ravenna	Styrene Monomer Plt.	14,000 tons/yr.	.....	Engineering	.....	Koppers	SBA	SBA
		*Butadiene Plt.	20,000 tons yr.	.....	Engineering	.....	Houdry	.....	.....
Destillerie Italiane	Milano	Butanol	11,000 tons/yr.	.....	Engineering	.....	Hoechst	Uhde	Uhde
Ente Nazionale Idrocarburi	Ravenna	Butadiene Plt.	30,000 tons/yr. Rubber	$75,000,000	Complete	.....	.....	Union Carbide Carbon;	Brown-Root
		Copolymer Plt.	350,000 tons a year		Complete	.....	.....	Phillips Petroleum	Brown-Root
		Ammonia Fertilizers	.....	.....	.....	.....	.....	.....	.....
Golfo Industria Petrolifera, A.P.A.	Gaeta	New Refinery	15,000 bbls.	.....	.....	.....	.....	Tecnider	.....
Isiom	Palermo	Refinery	15,000 bbls.	.....	Planning	1958	.....	Staff	.....
Mobil Oil Italiana S. p. a	Naples	Cat. Reforming	9,000 b'ls.	.....	Under Constr.	Oct., 1958	.....	CTIP	CTIP
		Cat. Hydrodesulfurisation	10,000 bbls.	.....	Under Constr.	Oct., 1958	.....	CTIP	CTIP
		Lube Expansion	.....	.....	Under Constr.	Oct., 1958	.....	Staff	Staff
Shell Italiana	Palermo	Refinery	20,000 bbls.	.....	Planning	.....	.....	.....	.....
Sincat	Priolo, Sicily	*Ammonia Unit	150 tons	.....	.....	.....	.....	Foster Wheeler	Foster Wheeler
Soc. Solvay & Cie	Italy	Polyethylene	.....	.....	Licensed	.....	Phillips	.....	.....
STANIC Industria Petrolifera	Livorno	Hydrofiner I	8,200 bbls.	$1,600,000	Engineering	June, 1958	Esso	CTIP	CTIP
		Hydrofiner II	8,200 bbls.	$1,600,000	Engineering	Sept., 1958	Esso	CTIP	CTIP
Netherlands									
Caltex Petroleum Maatschappij, N.V.	Pernis	Platformer	7,000 bbls.	.....	Complete	.....	UOP	Lummus, Ltd.	Lummus-Werkspoor
		Diesel Unifiner	4,000 bbls.	.....	Complete	.....	UOP, Union	Lummus, Ltd.	Lummus-Werkspoor
Esso Nederland	Rotterdam	Refinery	100,000 bbls.	$50,000,000	Engineering	Early 1960	.....	Esso	Badger, N.V.
Mekog	Velsen-Ymuiden	Nitrogen Fertilizer	.....	$9,000,000	Planning	.....	.....	.....	.....
Nederlandsche Dow Maatschappij N.V.	Rotterdam	Processing Plt.	.....	.....	Planned	.....	.....	.....	.....
N. V. de Bataafsche Pet. Maatschappij	Pernis	Syn. Glycerine	.....	$7,000,000	Complete	.....	.....	.....	Staff
		Cat. Reformer	12,700 bbls.	.....	Under Constr.	2nd Qtr., 1958	.....	.....	.....
		Hydrodesulfuriser I	16,400 bbls.	.....	Under Constr.	2nd Qtr., 1958	.....	.....	.....
		Hydrodesulfuriser II	7,800 bbls.	.....	Under Constr.	2nd Qtr., 1958	.....	.....	.....
		Alkylation Plt.	2,800 bbls.	.....	Under Constr.	1st Qtr., 1958	.....	.....	.....
Norway									
Standard (N.J.)	Oslo Fjord	Refinery	40,000 bbls.	$30,715,000	Engineering	.....	.....	Badger, N.V.	Badger, N.V.
Portuguese W. Africa									
Petrofina	Luanda	Refinery	.....	.....	Planning	.....	.....	.....	.....
Scotland									
British Hydrocarbon Chemicals	Grangemouth	Butadiene	.....	.....	Complete	.....	.....	KIC	KIC
		Polyethylene Plt.	25,000,000 lbs./yr.	.....	Under Constr.	Early 1959	Phillips	S&W; E. B. Badger, Ltd.	.....

* First appearance in tabulation. † Added capacity.

Construction BOXSCORE Continued on Page 253

Now: the SBA-Kellogg way to

ACETYLENE

C_2H_2

FROM NATURAL GAS OR NAPHTHA

Through special arrangement with Societe Belge de l'Azote (SBA), The M. W. Kellogg Company now can provide a continuous acetylene production process using naphtha or natural gas as feedstock. This improved process promises economies and results previously not obtainable.

Revolutionary Burner

The heart of this process is the SBA-developed burner. Easy to control, and requiring only minimum attention, it is stable and operates continuously—producing a constant yield. The formation of coke and tarry materials in the burner is virtually nonexistent. Any trace of these materials is automatically removed by special separation equipment.

Kellogg Cooperation

Through cooperative research and development by SBA and Kellogg, considerable engineering information has been developed on both the pyrolysis and purification systems. The results of this joint effort, available only from Kellogg, assure accurate and thoroughly reliable plant designs.

Process Highlights

Using naphtha feedstock, a wide range of ethylene to acetylene ratios may be achieved. This permits simultaneous production of ethylene and acetylene with great flexibility. In the case of natural gas feed, acetylene is the primary product—with negligible quantities of heavy impurities. If desired, the plant can be designed to operate on either feedstock.

Acetylene Purification

In the process train, the heavy acetylenes and hydrocarbons are removed first, leaving a stream containing acetylene and lighter materials. By using an SBA-developed ammonia absorption system, acetylene and ethylene are recovered from hydrogen and the other products of combustion, which in themselves are valuable by-products. The acetylene, 99.5% pure or higher, and ethylene are stripped from the ammonia. Ammonia makes this process safer than others because of its depressing effect on the explosibility of acetylene.

For More Information

Chemical companies and petroleum refiners interested in utilizing this advanced acetylene production process are invited to discuss their specific needs in person with The M. W. Kellogg Company. Please address inquiries to the Chemical Process Division.

CHEMICAL PROCESS DIVISION

The M. W. Kellogg Company

711 THIRD AVENUE, NEW YORK 17, N. Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Co. Ltd., Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., N.Y.
Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

For more data on advertised products, use Readers' Service Cards, last page.

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EVERY DAY IN

MAN HOURS ALONE

WITH THIS FILTER

(as reported by one processor)

Built to handle products with a high percentage of solids, with long operating cycles.

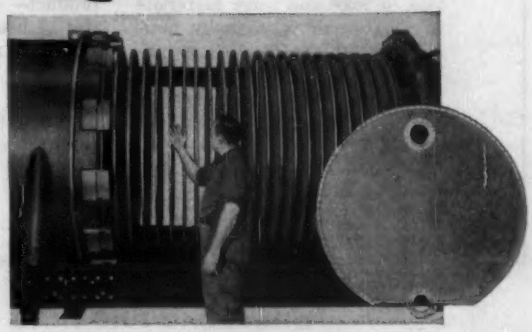
Engineered to lower filtration costs.
Fast cleaning with a minimum of down time.

Anyone interested in reliable uniform quality, highest daily volume production, and economical operation, will not be satisfied with anything less than a Sparkler MCR.

SPARKLER MODEL MCR
HEAVY DUTY FILTER

1. *Easiest and Quickest* instant opening cover. One throw of the lever and the cover is open or closed.
2. Retractable tank, hydraulic power operated with finger tip control.
3. No breaking of pipe connections with fixed head. No spillage.
4. Plates spread far apart to allow full size cake without clogging. Large top plate outlet and bottom drainage outlet reduces flow resistance.

Write for complete facts in bulletin



SPARKLER FILTERS

SPARKLER MANUFACTURING COMPANY
Mundelein, Illinois

Sparkler International Ltd. plants, in Canada, Holland, Italy and Australia

Exclusive filtration engineers for over 30 years

CONSTRUCTION BOXSCORE—*Continued*

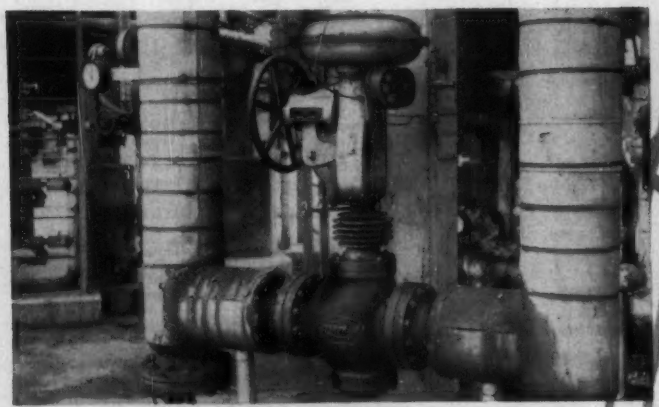
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
British Petroleum	Grangemouth	*Copper Chloride Unit	2,000 bbls.		Under Constr.	Late 1958		Power-Gas	Power-Gas
		*Kerosine Treating	2,000 bbls.		Under Constr.	Late 1958		Power-Gas	Power-Gas
		*Deethaniser	2,000 bbls.		Under Constr.	Late 1958		Power-Gas	Power-Gas
Union Carbide, Ltd.	Grangemouth	*Polyethylene Plt.			Under Constr.			George Wimpey & Co., Ltd.	George Wimpey & Co., Ltd.
Spain									
Hidro Nitro Espanola	Monzon	Ammonia Synthesis	22 tons		Complete			Uhde	Uhde
Refineria de Petroleos de Escombreras S.A.	Escombreras	Topping Unit	25,000 bbls.		Complete			Foster Wheeler	Foster Wheeler
		Platformer	11,000 bbls.		Complete		UOP	Foster Wheeler	Foster Wheeler
Sweden									
A. Johnson & Co.	Sweden	*Refinery Exp.						Bechtel	Bechtel
Turkey									
Badische Anilin and Soda Fabrik	Kutefia	Ammonium Sulfate	60,000 tons/yr.						
		Sulfuric, Nitric Acid	50,000 tons /yr.	$20,000,000	Planning	1958			
Mobil Overseas, Shell, Cal-Tex, BP	Turkey	Refinery	65,000 bbls.	$48,000,000	Planning	1960			
Turkish-American Oil	Istanbul	Refinery; Crude-Vacuum; Cat. Crker., Vapor Recovery, Cat. Poly. Treating	15,000 bbls.	$18,000,000	Approved	Dec., 1958		Kellogg	Kellogg
Turkish Government	Istanbul	Natural Gasoline Plt.			Planning				
Union of South Africa									
Standard-Vacuum	Durban	Refinery Exp.	25,000 bbls.	$9,000,000	Engineering			Foster Wheeler	Foster Wheeler
		Powerformer							
		Hydrofiner							
		Steam Plt.							
Union Petrol Refinery Ltd.	Johannesburg	Refinery		$20,000,000	Projected				
Yougeslavia									
Yougoslav Government	Dubrovnik	*Distill. and Treating	1,350 bbls.	$1,350,000	Planning	1960		Institute of Petroleum at Zegret	
	Sisak	*Topping and Stabilising	7,500 bbls.		Planning	1960		Institute of Petroleum at Zegret	
		*Ammonia Plt.		$15,000,000	Planning	1961			
	Pancevo	*Ammonia Plt.			Planning	1961			
	Zagret	*Reformer			Planning				
NEAR EAST									
Bahrain									
Bahrain Petroleum	Bahrain	Platformer	10,000 bbls.		Complete		UOP	Foster Wheeler, Ltd.	Foster Wheeler, Ltd.
Iran									
National Iranian Oil Co.	Kermanshah	Refinery Exp.	6,850 bbls.	$3,627,000	Engineering	1958	NIOC	C.J.B.	
Iraq									
Iraq Government	Baghdad	Refinery Exp.	48,000 bbls.	$11,000,000	Under Constr.	July, 1959	Esso	Foster Wheeler	Foster Wheeler
		Powerformer	5,000, bbls.			Sept., 1959		Foster Wheeler, Ltd.	Foster Wheeler, Ltd.
		*Kerosine Treating Unit	5,000 bbls.			Sept., 1959		Foster Wheeler	Foster Wheeler
	Qaiyarah	*Refinery Revamp Crude Topping; Vacuum Distill.; Thermal Cracking; Asphalt	7,500 bbls.			Late 1959			
Jordan									
Jordanian Reconstruction Council	Mafrak	Refinery		$7,500,000	Planned				
Kuwait									
Kuwait Oil	Mina alAhmadi	Two Distillation Units	80,000 bbls. each		Under Constr.	Early 1958		S&W; E. B. Badger; Bechtel	Bechtel
Neutral Zone									
Getty Oil Co.	Neutral Zone	*Crude Stripping	50,000 bbls.	$2,000,000	Under Constr.	1958		Parsons	Parsons
Saudi Arabia									
Arabian American Oil Co.	Ras Tanura	Hydrofiner	15,000 bbls.	$4,100,000	Complete		Esso	Lummus	Bechtel
Syria									
Esso Standard	Syria	Refinery	10,000 bbls.		Proposed				
Syrian Government	Homs	Refinery	20,000 bbls.	$11,000,000	Planning				
FAR EAST									
Ceylon									
Shell of Ceylon	Hendola	Refinery		$40,000,000	Planning				
China									
Hong Kong & China Gas Company	Hong Kong	*Catalytic Oil Gasification	1.5 mm cfd		Under Constr.	Autum 1958		Power-Gas	Power-Gas
India									
Alkali & Chemical Corp. of India	India	*Polyethylene Plt.		$4,580,000					
Indian Government	Bhavnagar	Refinery	30,000 bbls.	$42,000,000	Considering				
	India	Synthetic Pet. Plt.	6,000 lbs.		Planning				
Japan									
Asahi Chem. Co., Ltd.	Nobeoka	Ammonia Plt.	50 tons		Under Constr.	Autumn, 1958		Chemico	Chemico
Befu Chemical	Befu Harbor Honshu	Ammonia Plt.			Under Constr.		Texaco	Chemico	Chemico
Daikyo Oil	Yokkaichi	Houdriformer	3,000 bbls.	$2,200,000	Under Constr.	Early 1958	Houdry	Treco	Chiyoda
		Lube Oil Furfural Unit	840 bbls.	$720,000	Complete		Texaco	Texaco	Chiyoda
Furukawa Chemical Industries	Japan	Polyethylene			Approved		Phillips		
Idemitsu Kosan Co.	Tokuyama	Refinery	30,000 bbls.	$25,000,000	Complete		UOP; J.G.C.		
		*Sulfur Recovery Plt.	20 tons		Under Constr.	Early 1958	Girdler	Girdler, J.G.C.	J.G.C.
		*Unifiner	6,000 bbls.	$370,000	Engineering	Summer 1958	UOP	UOP; J.G.C.	
Koa Oil	Iwakuni	*Cat. Reformer	4,000 bbls.		Planning	Mid 1959			
Marusen Oil Co.	Osaka	Ethyl Ketone	15 tons	$3,000,000	Engineering			Chemical Proj.-ect Assoc.	Chiyoda
		Secondary Butyl Alcohol	15 tons						
	Matsuyama	*Udex Unit	70 tons	$2,200,000	Under Constr.	June, 1958	UOP	UOP; Japan Gasoline Co.	J.G.C.
		*Dicarboxylic Acids	30 tons	$6,250,000	Engineering	1959	Scientific Design	Scientific Design	
Mitsui Petrochemical Industries	Iwakuni City	Ethylene Oxide, Ethylene Glycol		$30,000,000	Under Constr.		Scientific Design	Scientific Design	
		Ethylene Unit			Engineering		S&W	S&W	S&W

* First appearance in tabulation. † Added capacity.

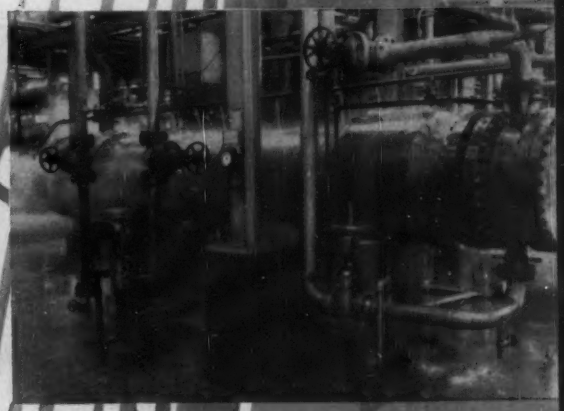
Construction BOXSCORE Continued on Page 257

Refinery Men Everywhere

Masoneilan Control Valve w/Positioner and Side-Mounted Handwheel on Alkylation Unit.



Liquid Level Control Valve on Feed Line to Heaters in a Sovaformer Unit.



Liquid Level Control Valve on a Heat Exchanger in Sovaformer Unit.

Say—

"We know M-N Equipment is Dependable!"

Where quality of product depends upon quality of equipment, it's a better-than-even bet that the controls include one or more items from the Masoneilan line.

Pictured here are representative Masoneilan controls at work in a modern refinery, where Sovaformer and Alkylation processes are used to produce high octane premium gasoline. Quality must be rigidly controlled. Only dependable, accurate valves and controllers can meet requirements. Here, as in other refineries all over the world, operating men say "Masoneilan equipment has proved to be dependable; we are confident in using it."

The Masoneilan line offers a wide variety of equipment on which you can depend. Take the first step toward becoming acquainted with Masoneilan Controls — write for catalog.

MASON-NEILAN

Division of Worthington Corporation

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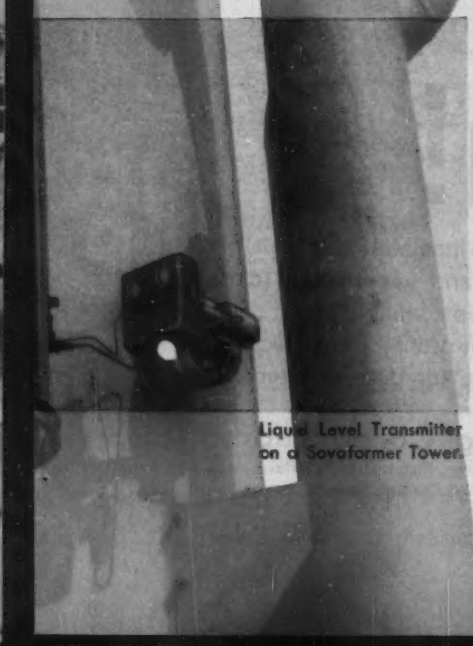
Major Product Lines Available from Mason-Neilan

- Control Valves • Liquid Level Controls
- Pneumatic Controllers
- Pressure Regulating Valves
- Temperature and Pressure Transmitters.

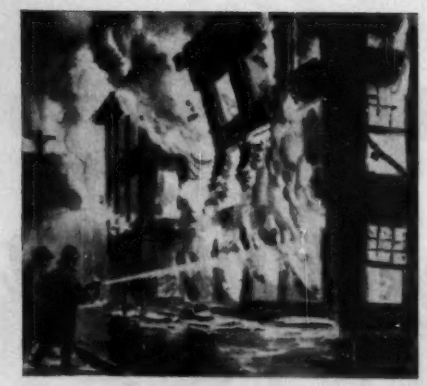


Liquid Level Transmitter on a Sovaformer Tower.

Operator Checks Control Valve on Heavy Naphtha Line to Absorber.

Left—Valve Controlling Fuel Gas Pressure.

Right — Emergency Shutoff Valve.



Some insulations feed a fire . . .

FOAMGLAS®

INSULATION won't burn!

—and only inorganic FOAMGLAS insulation offers all these added benefits . . . waterproof and vapor-proof (closed glass cell structure) . . . dimensionally stable . . . high compressive strength . . . vermin-proof . . . easy, economical to handle and install. Write for detailed literature.

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For more data on advertised products, use Readers' Service Cards, last page.

CONSTRUCTION BOXSCORE—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Mitsui Petrochemical Industries—(Cont'd)	Iwakuni City	Phenol Unit	.....	.....	Engineering	.....	Distillers, Ltd.	S&W	S&W
		Cumene Plt.	.....	.....	Under Constr.	1958	Scientific Design	Scientific Design	.....
		*Udex Unit	1,800 bbls.	.....	Under Constr.	Early 1958	UOP; Dow	UOP; J.G.C.	J.G.C.
		*Unifiner	500 bbls.	.....	Under Constr.	Early 1958	UOP	UOP; J.G.C.	J.G.C.
Mitsubishi Oil Co., Ltd.	Kawasaki	Platformer	3,000 bbls.	$13,700,000	Complete	.....	UOP	UOP	Chiyoda
		Unifiner	12,500 bbls.	.....	Complete	.....	UOP	UOP	Chiyoda
		Udex	750 bbls.	.....	Complete	.....	UOP	UOP	Chiyoda
Mitsubishi Petrochemical Co.	Yokkaichi	Ethylene	67.7 tons	.....	Engineering	.....	S&W	S&W, Japan Gasoline	Japan Gasoline
		Styrene Monomer	55.4 tons	.....	Engineering	.....	B.P.M.	B.P.M.	.....
		Polyethylene	30.8 tons	$28,000,000	Under Constr.	1958	BASF	BASF	.....
		Ethylene Oxide	9.2 tons	.....	Engineering	.....	.....	.....	.....
		Ethylene Glycol	9.2 tons	.....	Engineering	.....	.....	.....	.....
Nihon Gas Nagaku Kogyo	Niigata	Urea	905 tons	.....	.....	.....	.....	Chemico	Chemico
		Ammonia	100 tons	$2,100,000	Engineering	.....	.....	Chemico	Chemico
		Ammonia Sulfate	200 tons	.....	.....	.....	.....	Chemico	Chemico
Nippon Mining Co....	Funagawa	Lube Oil Furfural Unit	400 bbls.	$500,000	Complete	.....	Texaco	.....	.....
Nippon Oil Co.....	Niigata	Platformer	1,600 bbls.	$1,500,000	Engineering	1958	UOP	UOP; Japan Gasoline	Japan Gasoline
Nippon Petroleum Refining	Yokohama	Unifiner-Platformer	3,300 bbls.	$2,500,000	Complete	.....	UOP	UOP; Japan Gasoline	Japan Gasoline
		Lube Oil Furfural Unit	700 bbls.	$1,000,000	Engineering	1958	Texaco	Chiyoda	Chiyoda
Nippon Petrochemicals	Kawasaki	Ethylene	25,000 tons/yr.	$16,000,000	Engineering	Spring, 1959	S&W	S&W; Japan Gasoline	Japan Gasoline
		Butadiene	5,000 tons/yr.				Esso		
Showa Denko KK..	Tokyo	*Synthesis Gas Plt.	121 Short tons	.....	.....	.....	Texaco	Foster Wheeler	Foster Wheeler
Showa Yokkaichi Sekiyu Co., Ltd.	Yokkaichi	Refinery	40,000 bbls.	.....	Under Constr.	March, 1958	.....	.....	.....
Showa Yuka.....	Japan	Polyethylene	.....	.....	Approved	.....	Phillips	.....	.....
Sumitomo Chemical..	Niihama	Ethylene Unit	36.4 tons	.....	Under Constr.	Early 1958	S&W	S&W; Japan Gasoline	Japan Gasoline
Toa Nenryo Kogyo...	Shimizu	Ref. Exp. Powerformer; Hydrofiner; Kerosine Acid treating; Copper Sweetener; Offsite Facilities	32,500 bbls.	$12,500,000	Under Constr.	Late 1958	.....	.....	.....
		Pipestill	25,500 bbls.	.....	Complete	.....	.....	.....	.....
Korea									
Korean Government..	Chung-ju	Urea Plt.	285 tons	$25,000,000	Under Constr.	1958	Vulcan, Inventa, Texaco, Hydrocarbon	Hydrocarbon, McGraw, Vulcan	Hydrocarbon, McGraw
Sumatra									
Standard-Vacuum....	Palembang	Cat. Cracker	11,000 bbls.	.....	.....	.....	.....	Foster Wheeler	Foster Wheeler
		Polymerization	1,200 bbls.	$20,000,000	Planning	.....	.....	Foster Wheeler	Foster Wheeler
		Revamp Existing Plt.	.....	.....	.....	.....	.....	Foster Wheeler	Foster Wheeler
Formosa									
Chinese Petroleum Corp.	Kaohsiung	*Alkylation Unit	900 bbls.	$1,600,000	Engineering	1958	Texaco	Badger	Staff
		*Sulfur Recovery Unit	10,000 tons	$300,000	Engineering	1958	.....	Pintsch Bamag	Staff
Taiwan-Fertiliser, Ltd.	Nankong	Ammonia Plt. to Produce Urea	285 tons	$18,000,000	Complete	.....	Vulcan, Inventa	Hydrocarbon Vulcan	Staff
AUSTRALASIA									
Australia									
Bitumen & Oil Refineries	Sydney	Platformer	2,500 bbls.	.....	Complete	.....	.....	UOP	Staff
		Naphtha Unifiner	5,400 bbls.	.....	Complete	.....	.....	UOP	Staff
		Diesel Unifiner	2,500 bbls.	.....	Under Constr.	.....	.....	UOP	Staff
		*Crude Unit	12,000 bbls.	.....	Proposed	1958	.....	Procon	Procon
BP Refinery (Kwinana)	Kwinana	Cat. Reformer	10,000 bbls.	.....	Under Constr.	End 1958	.....	UOP, Kellogg	Kellogg
Imperial Chemical Industries of Australia & New Zealand	Australia	*Polyethylene Plt.	3,000 tons/yr.	$5,040,000	.....	.....	.....	.....	.....
Shell Refining (Australia)	Clyde	Cat. Reformer	6,700 bbls.	.....	Under Constr.	2nd Qtr., 1958	.....	.....	.....
	Geelone	Hydrodesulfuriser	11,000 bbls.	.....	Planned	1st Qtr., 1959	.....	.....	.....
Philippine Islands									
Shell (Philippines)....	Manila	Refinery	.....	.....	Negotiating	.....	.....	.....	.....
Standard-Vacuum...	Manila	Refinery	21,000 bbls.	$35,000,000	Planning	.....	.....	.....	.....

* First appearance in tabulation. † Added capacity.

NOTE:
Armistead—George Armistead & Co.
Atlantic—Atlantic Ref. Co.
Badger Mfg.—Badger Manufacturing Co.
Badger N. V.—Badger-Comprimo N. V.
E. B. Badger Ltd.—E. B. Badger & Sons Ltd.
E. B. Badger Pty.—E. B. Badger & Sons Pty., Ltd.
Barnes—W. M. Barnes Co.
Bechtel—Bechtel Corp.
Beck—Henry C. Beck
Blaw-Knox—Blaw-Knox Co.
Braun—C. F. Braun Co.
Brown & Root—Brown & Root Construction Co.
Buckner—F. J. Buckner Corp.
Calif. Res.—California Research Corp.
Can. Kellogg—Canadian Kellogg Co.
Catalytic—Catalytic Construction Co.
Chemico—Chemical Construction Co.
Ch. Pro.—Chemical Process, Inc.
C. B. & I.—Chicago Bridge & Iron Co.
Chiyoda—Chiyoda Chemical Engineering & Construction Co., Ltd.
C. & I.—Chemical & Industrial Corp.
C. J. B.—Constructors John Brown, Ltd.
Consd. Eng.—Consolidated Engineering Company
C.T.I.P.—Compagnia Tecnica Industria Petroli
D & Z—Day & Zimmerman
Delta—Delta Engineering Corp.
Dresser—Dresser Engineering Corp.
Ebasco—Ebasco Services Inc.
E&A—Ehrhart & Associates, Inc.
Esso—Esso Research and Engineering Co.
Edeleanu—Edeleanu Gesellschaft M. B. H.
Etabadger S.A.—Etablissement Badger, S.A.
Ferguson—H. K. Ferguson Co.
Fish—The Fish Engineering Corp.
Fluor—Fluor Corp.
Ford, Bacon, Davis—Ford Bacon & Davis Construction Corp.
Foster Wheeler—Foster Wheeler Corp.
Gas Plant Constr.—Gasoline Plant Const. Corp.
Girdler—The Girdler Co.
Girdler (Canada)—Girdler Corp. of Canada, Ltd.
Graver—Graver Construction Co.
Grebe & Doremus—Grebe & Doremus Process Co.
Gutte-Hutte—Gutehoffnungshuette
Hedrick—Wyatt C. Hedrick Engineering Corp.
Hercules—Hercules Powder Co.
Hudson—Hudson Engineering Corp.
H&G—Humphreys & Glasgow, Ltd.
H.W.P.—Head Wrightson Process, Ltd.
Hydrocarbon—Hydrocarbon Research, Inc.
Hydro M—Hydrocarbon Mineralöel G.m.b.H.
Hydro E—Hydrocarbon Engineering S.A.R.L.
Kaiser—Kaiser Engineers
Kellogg—The M. W. Kellogg Co.
Kellogg P. A.—Kellogg Pan American
KIC—Kellogg International Corp.
Kidde Engrs.—Walter Kidde Engineers Southwest, Inc.
Kidde Constr.—Walter Kidde Constructors, Inc.
Koch—Koch Engineering Company
Koppers—Koppers Co., Inc.
Litwin—Litwin Engineering Co.
Lummus—The Lummus Co.
Lurgi—Lurgi G.m.b.H.
Macco—Macco Corp.
McKee—Arthur G. McKee Co.
Olsen—O. L. Olsen
Parsons—The Ralph M. Parsons Co.
Pet. Comb. & Eng. Co.—Petroleum Combustion & Engineering Co.
Petreco—Petroleum Construction Co.
Power Gas—Power Gas Corp., Ltd.
Pritchard—J. F. Pritchard Co.
Procon—Procon, Inc.
Quaker—Quaker Valley Constructors
Russell—Russell Engineering Corp.
Rust—Rust Engr. Co.
SBA—Soc. Belge de L'Azote et des Produits Chimiques du Marly
Scientific Design—Scientific Design Co.
Southwestern—Southwestern Constr. Co.
Stearns-Roger—Stearns-Roger Mfg. Co.
S & W—Stone & Webster Engineering Corp., Chemical Division
S & W Canada Ltd.—Stone & Webster Canada Ltd.
Sweco—Southwestern Engineering Co.
Tears—Tears Engineers
Tellepsen—Tellepsen Petro-Chem Constructors
Treco—Refinery Engineering Co.
Tuloma—Tuloma Builders
Uhde—The Uhde Corp.
U.O.P.—Universal Oil Products Co.
Vulcan—Vulcan Engineering Div.

LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY

385 Madison Avenue New York 17, N. Y.

NEW LUMMUS DELAYED COKER FOR SOCONY MOBIL WILL CHARGE 19,000 B/D

Project scheduled for completion in early 1959

Socony Mobil has chosen Lummus to design, engineer and construct a 765 ton-per-day delayed coker for their Paulsboro, New Jersey, refinery.

The equipment is being designed for 19,000 barrels per day of charge composed largely of heavy mixed residual tars, supplemented with heavy vacuum gas oil stocks. Products will include — in addition to 765 tons of coke per day — dry gas and hydrogen sulfide, butane and butylenes, light and heavy gasoline, and light and heavy oil.

This installation will contain two separate coking heaters for greater flexibility, and four coke drums measuring 19 feet by 63 feet tangent to tangent. Other facilities include sections for fractionation, dehexanization, gas recovery, hydrogen sulfide recovery, coke handling, and related utilities.

This installation, when completed in early 1959, will bring the total of cokers designed and built by Lummus to 11, with a combined coke producing capacity of 5,000 tons per day, over ⅓ the overall total yielded in the United States.

When you plan a new facility—or a complete refinery—Lummus can put 50 years of experience, on more than 700 plants throughout the world, to work for you.

The Lummus Company, 385 Madison Avenue, New York 17, N. Y. *Engineering and Sales Offices and Subsidiaries:* New York, Houston, Baton Rouge, Montreal, Caracas, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Washington, D. C. *Engineering Development Center:* Newark, N. J.

Artist's rendering of 765 ton-per-day delayed coker for Paulsboro, N. J., refinery of Socony Mobil.

Why Information Research?

The advancement of oil industry research is being threatened by its own unorganized mass of knowledge.

Edmond L. d'Ouville,
George E. Schmitkons and
J. W. Mohlman
Research Department, Standard Oil Company (Indiana)
Whiting, Ind.

THE OIL INDUSTRY is deep in the clutches of a progress-destroying paradox:

Advancement of industrial research is being threatened by its own mounting bulk of previously discovered knowledge.

In nearly every instance, the success of a research team's efforts is determined by familiarity with earlier work.[1] However, the mountainous mass of technical literature is growing so fast, proper familiarity is becoming increasingly harder to get and hold.

This broad problem of industrial research must be solved if the U. S. oil industry is to keep abreast of fast-growing world technical and product developments.

As a point of recognition, those who organize and condense information are keeping the problem from getting entirely out of hand. These scholars are reducing the volume and increasing the potency of published information. Their work cannot be hurried, scheduled or controlled. It should be encouraged and appreciated; for without it, the advance of knowledge will be throttled by its own unorganized mass. However, this group needs help—and plenty of it.

To illustrate the gravity of the situation, the National Science Foundation, National Research Council and American Documentation Institute will hold an international conference late in 1958 in Washington

PERFOMANCE OF AN INFORMATION-RESEARCH TEAM

	MONTHS OF ACTIVITY	PARTICIPANTS FROM TEAM	NUMBER OF REPORTS
Petrochemical Project	21	4	42
Reforming Project	18	4	42
Aromatics Projects	6	2	13
22 Additional Projects	1.5[a]	1.4[a]	
(10 minor projects and 12 appraisals)			39
			132

[a] average per project

FIGURE 1—Standard Oil Company (Indiana) information research team carried out the above projects over a 30-month period.

Why Information Research? . . .

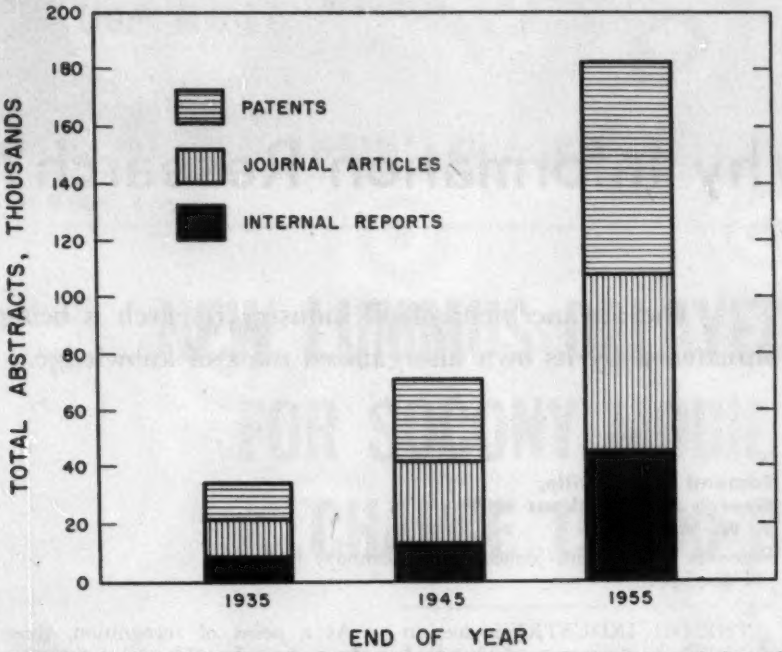

FIGURE 2—The above chart clearly illustrates the mass growth of patent, trade journal and internal report abstracts at Standard Oil Co. (Indiana) since 1935. Nearly every oil company could make an identical report.

to examine present developments on organizational dissemination and retrieval of scientific information.

The Oil Industry Problem. The situation in the petroleum field can best be illustrated by the growth of one company's [Standard Oil Company (Indiana)] card file of bibliographical references. For 25 years Indiana Standard has systematically selected and abstracted technical information. The company's abstracts include patents, articles from scientific and trade journals, and reports of internally developed information. Figure 2 shows the accelerating growth in each of the three categories.

During the decade 1935 to 1945, the total number of items doubled—from 34,000 to 70,000. During the decade 1945-1955, the accumulation more than doubled—to more than 180,000. If this trend continues, Indiana Standard alone could have about 400,000 selected items in file by 1965.

Look at the impact this growth has had on two specific topics: catalytic cracking and catalytic reforming. Intensive study of catalytic cracking, which began about 1935 and still continues, has led to 450 journal articles and more than 2000 U. S. patents. It would take a person more than a year merely to read them. Catalytic reforming of naphthas has produced 450 journal articles and more than 1200 U. S. patents. Hardly anyone has been able to master such a bulk of information.

Three Changes Have Helped. Despite the mounting difficulty, the industry has forged ahead in research. Three changes in research practice have helped save time for the researcher so that he could know the literature in his bailiwick:

1. Narrowing the fields of specialization.
2. Shifting from individual to group effort.
3. Providing services.

However, each of these expedients has drawbacks.

Specialization has been effective because it narrows the field one must master to do successful work. But too much specialization leads to loss of perspective.

Shifting from individual to group effort divided the burden of knowing what has been done and what is being done, and of carrying forward experimental developments. But it aggravates the problem of communication. The week is spent attending conferences and writing reports. Increased specialization and group work have required increased vigilance to achieve coordination—to avoid gaps and overlaps.

The third expedient, **providing research groups with the services of other groups,** compounded the specialization. Mechanical experts provide special equipment. Analytical work, once time-consuming for the researcher, is done on a routine basis by an army of analysts. Specialists handle product evaluation.

Calculations are performed by a group having experience in the use of electronic as well as human brains. Literature service is also provided; alert librarians, abstractors, and searchers handle information by techniques which someday may be partly mechanized. All these services of other groups give the researcher more time to digest prior information, to keep abreast of developments, and to add his bit.

Needed: A Fourth Expedient. But success in research is not assured by perfect services. Effort spent in blind alleys and in duplicating earlier experimental work squanders the costly services. The costs of genuine and pseudo-research have gone up together.

Despite the drawbacks, these expedients help creative research in the face of the expanding new knowledge and must be retained in full. However, they are already near their practical limits. Moreover, they are indirect.

A new expedient that takes direct action on the use of information, has been perfected over the past five years in the Whiting Research Department of Standard Oil Co. (Indiana). It is called Information Research.

Information Research. There has been wide recognition that a new kind of literature scientist might help fulfill the need for direct action (1-9). A team of literature scientists should be able to go even farther.

The function of such a team of interpretive information specialists, working together to solve specific problems by using available information only, may be called "Information Research."

Internal and External Information. An Information Research team uses both internal information—that

arising within its own research organization—and external information—that published, in the process of being published, or obtainable for a moderate fee or on a good-will basis. The team does no experimental work; it endeavors to solve problems by using existing information exclusively, although it occasionally requests an experiment when that is the best way to fill a gap.

Working as a separate group, these men use their talent full time to solve technical problems, either alone or with one or more bench-scale, pilot-plant or design groups. The team should make full use of conventional literature service and also seek information in unusual places and by extraordinary means.

As an experimental program goes forward, relevancy of other fields of information develops as the results turn the efforts in new directions. Rarely can one define his needs in requesting a literature search at the start of a project. Information Research takes these facts into account and continually readjusts its sights and objectives as the project goes along.

Must Use High Caliber Personnel. The qualifications for membership on an Information Research team are exacting. Men of initiative who have a broad experience with literature and the ability to do high-caliber technical work are required.

One can find a few likely candidates in every large organization. They are scientists who have an outstanding ability for keeping in touch with information—old and new. They combine good memories with a keen interest in science. Put together to work as a team, such men with capacity for research and skill in finding and interpreting information enhance their skills and develop new ones.

Information Research offers enough challenge to spark the interest of alert individuals. It is no ordinary privilege for a researcher to have an assured part in solving the big problems of the laboratory. Few assignments offer as good opportunities for getting a broad view.

A balance of experience within the team is needed, and certain special talents are essential. If the team is allied with a petroleum laboratory, both chemistry and chemical engineering should be represented.

One member must be able to handle the main sources of information in foreign languages. Another should be adept at making inquiries within and outside the laboratory to tap sources of unpublished information. All must be competent to appraise the fine points of at least the major current problems.

Assignments Can Vary. The Information Research team should be regularly assigned to advance projects where experimental, development or design groups are active. Such projects offer a unique opportunity for important contributions; otherwise, a "let George do it" attitude is likely to prevail with respect to sifting and interpreting the bulky information.

The team provides insurance against prolonged repetition of older work. Progress on genuine new leads is hastened by promptly nourishing them with relevant information and by quickly weeding out unfruitful proposals.

Besides giving sustained attention to one or two major projects, the team can usually handle a few minor assignments. On the major projects, the whole team may work together, each member surveying a prescribed area and employing his particular forte in locating and interpreting information. The minor assignments may often be handled by individual members of the team, with only incidental assistance from teammates.

The team should be allowed considerable independence of judgment in the mode of attack on a problem and in the choice of minor assignments. Although others seek its help on many urgent and attractive problems, the team should be encouraged to initiate some of the new assignments as the result of its own promising leads.

How the Team Works. An Information Research team was established at Indiana Standard's laboratories in 1952. The performance of the team for a 30-month period is summarized in Table I.

The team worked on three major projects and on 22 minor assignments. As a rule, two major and one or more minor projects were handled concurrently. Reports were issued whenever information was unearthed, a new interpretation could be given to old information or a discrete phase of an assignment was completed. In addition, those most concerned were kept informed orally.

Projects Were Diversified. One major petrochemical project demanded at least part-time attention of all members of the group. This project was receiving full treatment from bench-scale, pilot-plant, engineering-design, and market-survey groups. When money and manpower are being poured into a project at such a rate, it merits Information Research for that reason alone. During a 21-month period, the four-man team brought information to bear on all phases of the project and issued 42 reports.

Catalytic reforming was also studied at some time or other by all members of the team. This project was old at the time the Information Research team was established. Over an 18-month period, 38 reports were issued.

The third major project involved the production and uses of aromatic hydrocarbons. Two members of the team issued 13 reports over a period of 6 months.

The 22 minor projects comprised

Six Reasons Why Who Shoul Use Information Research:

1. **Saves money.**
2. **Provides quick, convincing information.**
3. **Allows more accurate appraisals.**
4. **Provides interpreted, rounded surveys.**
5. **Encourages literature appreciation.**
6. **Produces valuable incidental "finds."**

problems on gasoline, lubricants, and specialties, as well as on refining and petrochemical processes and plant operations. From one to four reports were issued per project, totalling 39 reports. The time spent on individual projects varied from less than a week to 3 months, averaging six weeks and accounting for roughly 30 percent of the team's work.

Appraisals Are Important. In both major and minor projects, appraisals of proposed courses of action were a particularly effective type of study. Such appraisals either determine whether a proposal should be carried out, or which of two or more courses of action is best.

An appraisal should be a critical evaluation based on carefully selected information. A well-rounded, short appraisal is more useful than an exhaustive list of references. Whenever possible, an appraisal should be built upon a good literature search. In all cases, it should be completed to the point of making concrete recommendations.

In several cases, the Information Research team, using an earlier search as a springboard, showed why the proposal was worthy, clearly defined the experimental and design work necessary for probable success, and recommended that the work be done.

In one instance, Information Research proved that a seemingly attractive proposal was doomed to failure. The proposal previously looked so good that pilot-plant work was already scheduled. After about a week, the Information Research team reported that the expected high yields could not be achieved in full-scale equipment. This was the deduction from a comparison of two apparently unrelated references.

Furthermore, one member had a clue that another company had already tried the process on a pilot-plant scale. An information-exchange conference was arranged and the conclusion was substantiated: the other company had thoroughly tried the proposal without success.

Other Advantages. Speed is often important in Information Research. The team has demonstrated its ability to assemble and interpret cogent information on short notice.

In several cases, the team faced a deadline because management chose to make a prompt decision on a technical question. Although intense, the study was necessarily brief. Providing information for quick decisions is a bonus benefit of Information Research.

Saves Money. Several "finds" have clearly saved thousands of dollars of experimentation. The successes of the Information Research team have increased the respect of the whole research staff for the literature.

Moreover, because the team has intimate contact with the conventional literature services, its members are able to offer ideas for improving literature and library services available to others. Increased information work by many individuals outside the Information Research team strengthens the over-all research effort.

Eliminates "Chance." Information Research sometimes resembles the work of scholars in organizing and condensing information. The efforts vary from "skimming the cream" to going all out in looking for a particular needle in the haystack.

Some elements of Information Research are not brand new. Most persons doing research seek available information. Successful research directors have always skimmed all sources of information; it is an essential part of their job. The first research man in a small organization often begins by working solely with information.

The novelty of Information Research lies in combining these elements through team effort, directed mainly to a few selected problems. This new endeavor is important to research management: no longer must the use of existing information be left to chance on all problems. Now it can be assured and intensified on the most urgent ones.

This is a new control on the research machine. It can be manipulated effectively and economically.

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Edmond L. D'Ouville is divisional director of research and senior technologist for Standard Oil Company (Indiana). After obtaining his Ph.D. degree in organic chemistry at the University of Pennsylvania in 1937, he entered Standard's research laboratories at Whiting. During 1942-44 he was the Koppers research fellow at Mellon Institute in Pittsburgh. From 1944 to date he has specialized in technical information and patent aspects of petroleum and petrochemicals. D'Ouville is currently chairman of the Industrial and Engineering Chemistry division of the American Chemical Society.

Mohlman

Schmitkons

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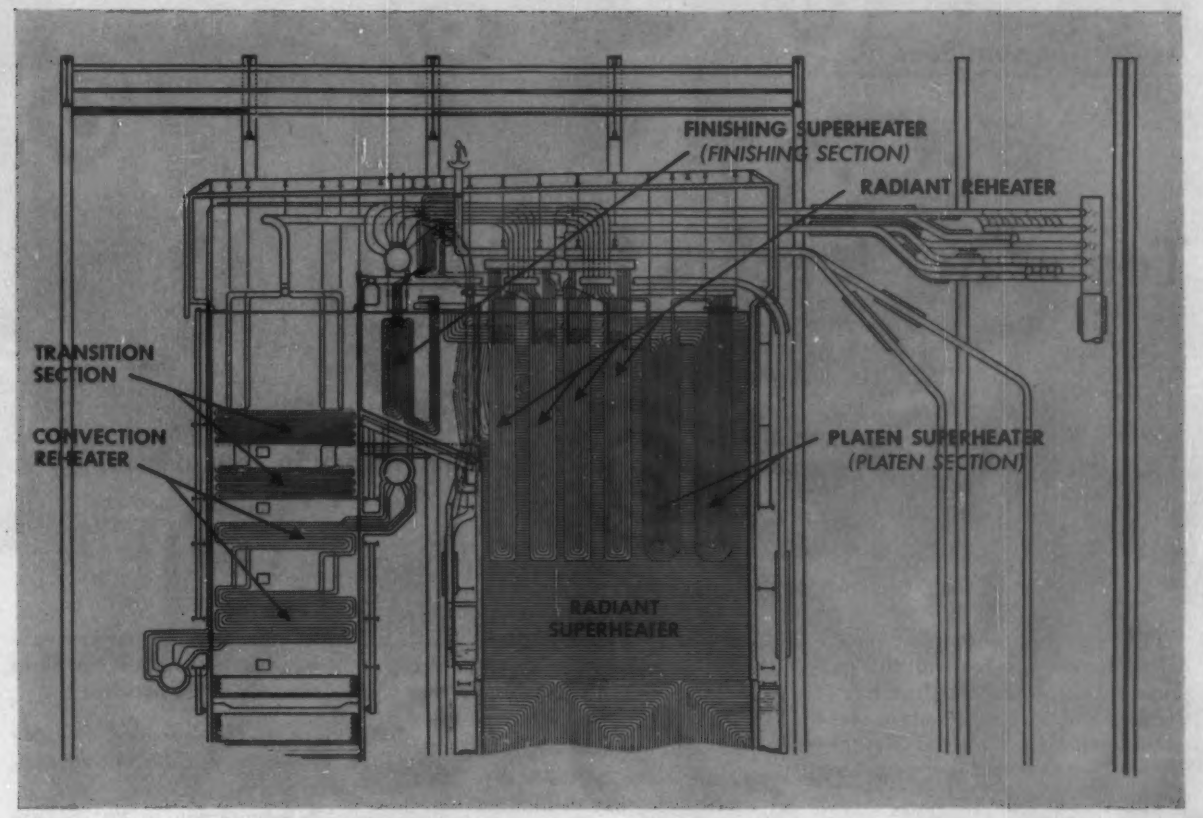
J. William Mohlman is head of information research at Standard Oil Company (Indiana). Upon obtaining his M.S. degree in chemical engineering at MIT in 1940 he joined Carbide & Carbon Chemicals Corporation and worked on process design and in manufacture of methanol for two years. After a brief service with Lummus Company on a butadiene project he joined Standard Oil Company (Indiana) and has since been in process design, manufacturing, chemical market research, and patents and technical information.



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TEST YOUR knowledge of the federal income tax law with this quiz prepared by the American Institute of Certified Public Accountants in cooperation with the Internal Revenue Service. You will find the correct answers on Page 267.

1. *When you were transferred to another city, your company gave you a sum of money toward the cost of moving you and your family. For tax purposes you should consider this money as . . . .*

(a) A gift that is not taxable

(b) Income that is subject to tax with a deduction for only your personal moving expenses

(c) Income that is subject to tax with a deduction for the cost of moving your entire family

2. *You have invested in several blue-chip stocks. The dividends received from this investment are exempt up to . . . .*

(a) $50 whether you or your wife owns the stock

(b) $100 if the stock is held jointly by you and your wife

(c) $100 regardless of who owns the stock, providing you file a joint return with your wife

3. *You are not permitted to deduct as contributions your donations to which of the following organizations . . . .*

(a) Charitable societies

(b) Educational institutions

(c) Political parties

4. *Your daughter, who was hospitalized for several weeks in the earlier part of 1957, was married in November. If she files a joint return with her husband, you may . . . .*

(a) Not claim her as a dependent but you may deduct her medical expenses

(b) Claim her as a dependent and deduct her medical expenses

(c) Not claim her as a dependent and you may not deduct her medical expenses

5. *You filled very few inside straights during the past few months and lost approximately $300 to the members of your Thursday night poker club. You should . . . .*

(a) Deduct the loss in computing adjusted gross income

(b) Subtract the loss from adjusted gross income

(c) Give up poker and start watching television on Thursday nights

6. *Last October your car skidded on a wet road and grazed a telephone pole. The damage was not covered by insurance and it cost you $100 to have the car repaired. To claim a casualty deduction . . . .*

(a) You must have the damage repaired within 30 days of the accident

(b) You may simply deduct the amount of the repair bill

(c) You must prove that you were using the car in your work at the time of the accident

7. *Which of the following may you not consider as a deductible business expense . . . .*

(a) A subscription to Petroleum Refiner

(b) Commutation fees

(c) The costs of attending engineering society conventions

8. *While playing hide-and-seek in your backyard, the neighbor's children trampled and killed several of your more expensive bushes. The cost of replacing this shrubbery . . . .*

(a) May be deducted if it does not exceed the original cost of the bushes

(b) May be deducted only if the parents of the children refuse to pay damages

(c) May not be deducted under any circumstances

9. *Last year you gave your church a small piece of property for which you had paid $500 some time ago. Its value at the time of the gift was $1500. As a result . . . .*

(a) You may claim a tax deduction of $1500

(b) You must pay a capital gain tax on the $1000 increase

(c) You may claim a tax reduction of $500

10. *After you have filed your personal 1957 tax return, the government*

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is allowed to check your return and bill you for additional tax. The period of time in which this may be done ends . . . .

(a) On the day you file your 1958 return

(b) Two years after you file your 1957 return

(c) Three years from the due date of your 1957 return

11. *On the advice of a friend, you engage a CPA to prepare your 1957 tax return. The fee he charges for this service is . . . .*

(a) Not deductible since it is a personal expense

(b) Not deductible if you are entitled to a refund

(c) Deductible in full

CORRECT ANSWERS

1. (c) The money you received from the company must be reported as income, but you may deduct the cost of moving your entire family. If the amount the company gives you exceeds your expense, the excess is taxable. Conversely, however, if your expenses were more than the amount received, the difference is not deductible.

2. (a) and (b) are both correct. All taxpayers are entitled to a $50 dividend exemption. A husband and wife can combine their exemptions and receive $100 in dividends tax free, providing the stock is jointly owned. The filing of a joint return will not qualify them for this double exemption if the stock is held in only one of their names.

3. (c) You cannot deduct contributions to an organization which spends a substantial part of its time lobbying or distributing political propaganda

4. (a) You gained a son-in-law but lost a $600 dependency exemption for 1957 when your daughter married in November. All is not lost, however. If you provided more than one-half of your daughter's support during the year, you may claim her medical expenses as a deduction on your return.

5. (c) Watching television can be most relaxing and it might even help you to forget your poker losses—which is the thing to do because net gambling losses are definitely not deductible. Net gambling gains are taxable as income; so if you won money in a football pool or other sources, you may use your poker losses to offset these gains.

6. (b) the IRS has ruled that "if the repairs do nothing more than restore the property to its condition immediately before the casualty and do not add to (its) value, utility or useful life, such repair costs may be used as a measure of the value of the destroyed portion." Where you were going at the time of the accident does not affect the deductibility of car damages.

7. (b) Commutation fees are not a deductible business expense. The cost of going to and returning from work, whether it be by bus, cab, train or plane, is not deductible since it is a personal expense. On the other hand, a and c are deductible.

8. (c) Damage to your shrubbery caused by children, dogs or errant lawnmowers is not deductible. If your home or lawn is damaged by fire, storm or flood the loss not covered by insurance may be deducted. When large amounts are involved it is wise to have an expert appraisal made immediately after the casualty.

9. (a) Your deduction for a charitable contribution is the value of the gift at the time it is made. You are not considered to have realized a taxable gain or deductible loss when you give property away. You may claim a deduction for the entire $1500 so long as this amount does not exceed 20 percent (30 percent in some cases) of your adjusted gross income.

10. (c) In the absence of fraud or substantial understatement of income, the Government has three years from the due date of your 1957 return to check your return and bill you for additional tax. Since the due date of most individual returns is April 15 and for investigation purposes all returns are treated as though filed on the due date, you should be sure to save all check stubs and receipted bills to prove your declared deductions until April 15, 1961.

11. (c) The fee which a CPA charges you to prepare a tax return or defend the accuracy of your return before the Treasury department is deductible in full if you itemize deductions.

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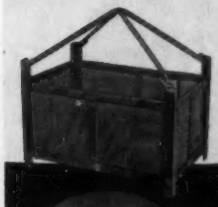

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STATISTICS SHOW that of 100 men employed, 20 will be of a superior type, 60 will be average and 20 will be of an inferior type. The latter 20 percent are the main contributors to a high frequency rate of accidents.

By following a careful screening process, making use of all the available information on an application form, the employment officer may be able to improve the statistics to come up with 20 superior employes, 70 average and only 10 inferior.

How Can Application Forms Promote Safety? They make available at once such information as age, marital status, education, previous employers, etc. These items provide information useful to the employment officer in the important undertaking of screening job applicants.

It is interesting to see how just this much information can be of real importance to an employment officer in the oil industry. The first item of age is important because the oil industry does not employ any person for field work who is not 20 years of age. In most cases applicants who have reached 21 years are preferred. This is because statistics indicate that from the age of 25 downward, the frequency rate of accidents increases until it reaches an alarming incidence among those persons under 21. The industry feels it has reduced its accident experience simply by not employing those persons shown to be more liable to suffer disabling injury.

Marital status, too, can assist the employment officer in a decision. Again, statistics indicate the married employe—all other things being equal—is more inclined to work safely. This does not eliminate the employment of single persons but it often does put the married applicant in a favored position. Usually the married employe has begun to recognize his responsibilities and has become a more stable individual. By considering such factors, as shown on a job application card, the employment officer can reduce the liability against a careless or unsafe worker.

The question of educational standards is important to safety programs too. It is generally agreed that a senior matriculation or final high school diploma is not necessary for a

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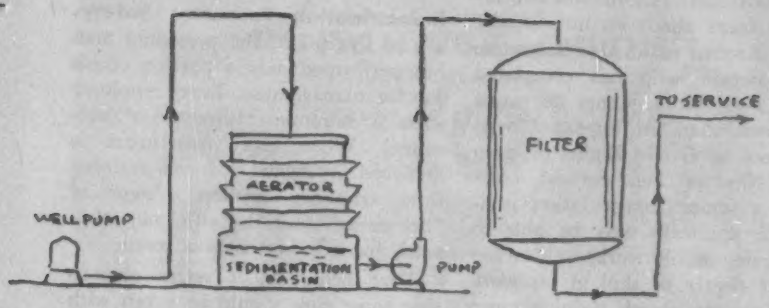

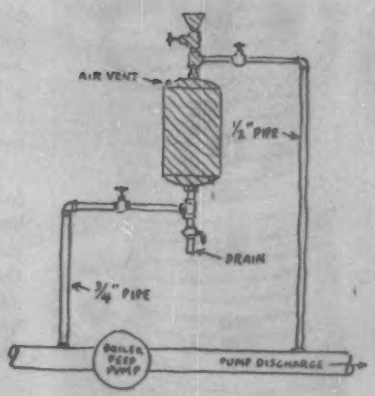

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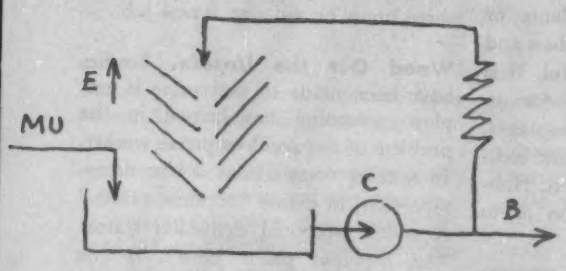

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man to be a good refinery employe or to make him less liable to suffer an accident. But it also is agreed that senior matriculation indicates two interesting traits about an individual.

First, it seems reasonable to assume that a person who has completed Grade 12 exhibits a higher degree of intelligence than an applicant who left school at Grade Eight, or even Grades Nine or Ten. Second, completing a senior matriculation indicates the applicant may be able to concentrate on his work, to develop a higher degree of skill in his work and be able to absorb training more readily.

Further down most application forms, space usually is provided to list the previous places of employment and types of work followed in the previous ten year period. Here again, the employment officer can find clues to the applicant's nature, knowledge and ability.

If the applicant has been engaged in work similar to that for which he is being considered, the chances are good he will require a minimum amount of training on the new job. If he lists only two or three employers during the previous 10 years, it could indicate a stable nature. It could also mean the applicant is industrious, seeking to better his position by making a worthwhile change. Conversely, the types of work listed may indicate the fly-by-night employe, who has switched jobs frequently and probably will do so again. Usually he is an uninterested worker and often careless on the job.

Even the space in which the applicant lists any special talents or training and indicates his hobbies and special interests, can be helpful. It is not necessary in most jobs for an applicant to speak several languages, but that information still might indicate a stable, ambitious person. Hobbies, too, give some direction as to personality and character.

On the other hand, many employment officers make little use of the references asked for and listed. In many cases the applicant lists several personal friends among those who know him and are willing to speak in support of his job application. Personal friends too often give biased reports when asked to comment on the applicant, thus minimizing the usefulness of the information.

Indoctrination Promotes Safety. Up to this point, the personnel man has performed only a portion of his job for management. Every employer seeks a minimum turnover of personnel. When that minimum is achieved it means reduced training time, employes develop a sense of "belonging" and the efficiency of a work force increases as a result.

That being so, it seems obvious that some care should be taken with the induction of a new employe. Many employers have fallen down on this matter of induction, according to some labor authorities. It is argued that employers must try to establish in the new worker's mind that new opportunity awaits him in a position that offers a good future with opportunity for advancement, increased earnings and job security. He should be made to feel he is an important part of the organization he has just joined.

Proper job induction must go still further, for even if the new employe is totally inexperienced or if he has worked in a similar occupation with another firm, he must be made acquainted with the new job. In the oil industry, if he is to work with a crew of men, he should be introduced to each crew member. Procedures used on the job must be explained, covering the overall operation in general and the man's particular job in detail. Such precautions will reduce the number of disabling injuries suffered by employes during the first two or three hours or shifts on a new job.

Weed Out the Unsafe. Studies have been made to determine if employe screening has helped in the problem of the accident-prone worker. In making comparisons it was necessary, first, to define "accident-prone." A widely accepted definition states: "An accident prone person is one whose characteristics and behavior are such as to make him considerably more liable to injury than the average person." Such a person will not respond satisfactorily to the usual methods of training.

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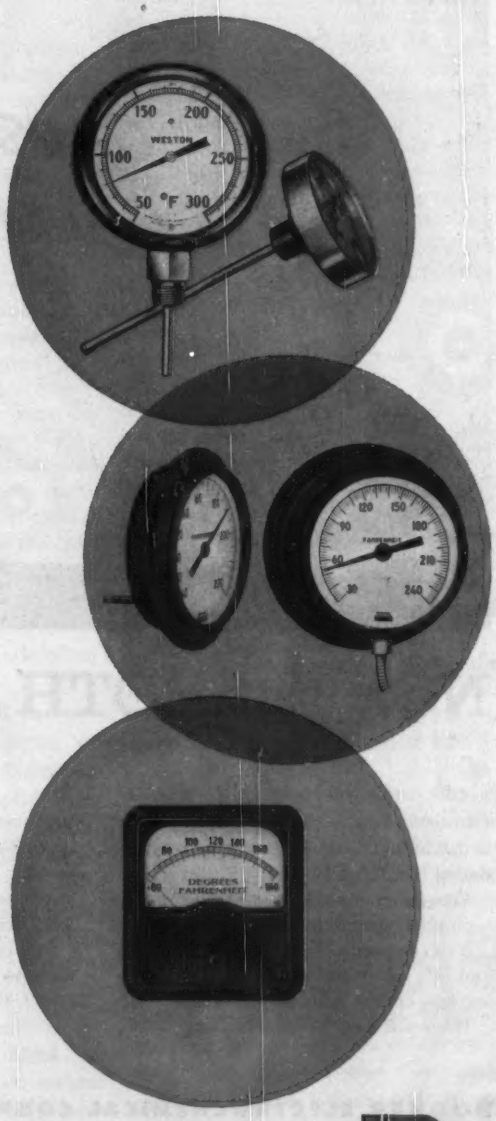

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repeater." The latter may have more than one accident but often these are the result of other circumstances, such as material or equipment failure, and whose experience can be corrected with a proper training program. But the accident-prone worker, whom industry strives to avoid, comes within the 20 percent group acknowledged to be of inferior ability. Only careful screening can catch him before he is signed to the payroll. If intelligent selection methods are not followed, the accident-prone workman may infiltrate an organization with a resultant increase in the frequency rate of accidents.

On the other hand, the accident repeater is known to be the result of other causes. First, it may be physical inadequacies such as eyesight or hearing, nervousness or a lack of physical ability for a particular job. The preemployment medical will bring most of these to light and the information is passed along to the contact supervisor. Such a man still is employable but subject to certain work limitations. Frequency of accidents he will suffer will be in direct proportion to the attention given to correction of his physical inadequacies.

Motivation faults may contribute further to mishaps by the repeater. These could be distaste for the job, lack of will to work, dislike of a supervisor of fellow workers, or both. Situations like this often come to the attention of a personnel officer and it is his responsibility to suggest remedial action. If such is taken there is less likelihood of the employe suffering disabling injury.

Two other factors which may cause accidents are lack of sufficient intelligence and lack of sufficient manual skill to perform work properly or accurately. So far as the first is concerned, it is the responsibility of screening officers to see that workers lacking in intelligence do not get into an organization.

The lack of manual skill is known to be the cause of many accidents. Development of skill to required levels often can be achieved through help from supervisors, but planning proper training programs to make such development possible can be the responsibility of personnel departments. To insure that supervisors accept responsibility for their parts in training programs, it is necessary that all levels of management show concern and support steps taken to increase workers' skills.

Management must face up to its responsibilities regarding the individual who does not respond to training. Such a worker should not be permitted to continue on the job. If no other job is available within his capacities, his services should be terminated.

Some supervisors are reluctant to fire any worker, but an employe is done no favor by being kept on a payroll if he faces possible disabling injury on the job. The worker who can not increase his competence through training should not be prolonged in a job for which he is unfit. The longer he remains in such a job, the less chance there is of his getting established in work at which he can be a success.

Use Appraisal Reports. But all this attention and effort in the selection of new employes is wasted unless a continuing program is followed to determine their real worth. In this respect, the personnel department can play a useful part by maintaining a series of appraisal reports. This method is followed in many firms, with reports compiled at regular intervals during employment.

It is believed that if work is not satisfactory, it cannot be corrected unless the employe is made aware of his shortcomings. To establish those, regular appraisals are needed to make efficiency assessments. If work is satisfactory, the employe is told and he is encouraged to continue to improve. Firms using appraisal report methods believe that if such a program is successful more skilled workmen will be developed, automatically developing safer workers and automatically reducing the frequency rate of accidents.

The personnel officer has an important role in this if he is assigned the responsibility for developing suitable on-the-job training programs. He can assist management in spotting training needs and developing training programs to meet those needs. It is an overall management responsibility. There is no point in defining the employe's shortcomings if no plans are made to help him correct poor work habits. ##

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What Part Does Oil Play in Railroading?

Ask any railroader what motivates his work and probably nine times out of ten his answer will be "oil." Today more than 26,000 oil-burning diesels have replaced almost 90 percent of the old-fashioned steam locomotives operating ten years ago, at a great economy in fuel. On the average, one diesel has been able to replace two or three steam engines. Oil fueled diesels transported an estimated 650 billion net ton miles of goods last year, consumer well over 3½ billion gallons of diesel fuels.

What Does It Cost to Increase Gasoline Quality?

American motorists like luxury travel—and the powerful, high compression cars they demand need top quality, high octane gasolines. According to one estimate, by 1958 it will take a fuel of about 95 octane to get top performance out of 90 percent of the cars on the road. And if present trends continue, high performance cars may require 110 octane gasolines by 1960. This is an expensive proposition when you consider that it costs the oil industry about $100 million to increase the national average gasoline octane rating by just one point.

Is Oil Getting Harder and More Expensive to Find?

Drake's well, which marked the commercial discovery of oil in 1859, produced from a depth of 69½ feet. Today the deepest production is from rock 20,741 feet deep in the earth. Cost to drill: $2.5 million or $110 a foot. Every year oil men have to drill deeper to find oil, and there's no peak cost in sight. One company has estimated there will be an 1100 percent increase in wells drilled 18,000 feet and deeper in California and the Gulf Coast—from seven in 1956 to 82 in 1965. Cost will soar skyward as the wells sink deeper.

How Do You Find Oil?

Oil men will go to any lengths to find the elusive mineral. One oil company uses a unique mountain-building machine to reconstruct the earth on a miniature scale. Sheets of rubber and clay representing rock layers are placed in a box with hinged sides that allow its deformation. By applying pressure to the sides of the box, folds equivalent to hills and mountains can be formed in the clay and rubber layers. Using this machine, scientists hope to get a clearer picture of how and where oil traps are formed in mountain areas.

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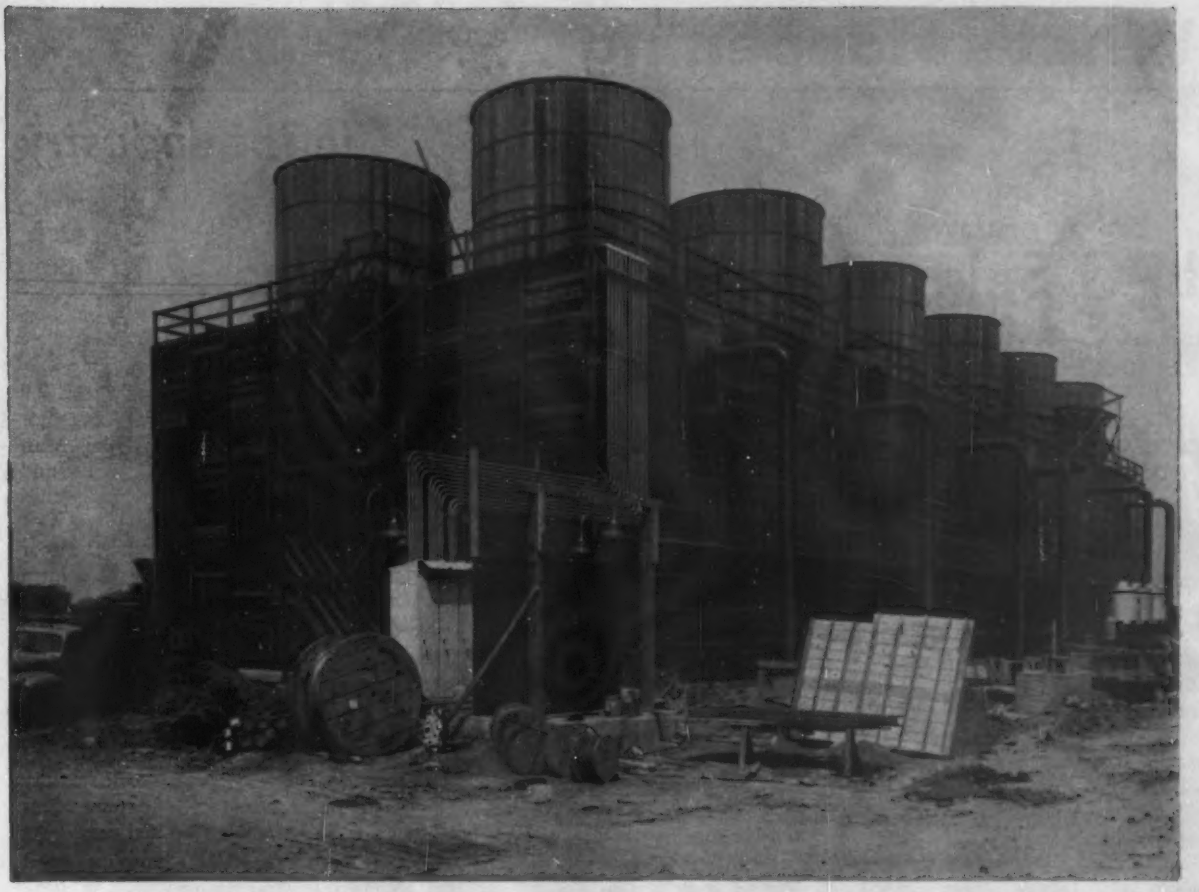
Taxes and fees collected directly from the oil and gas industry or the product it sells, account for more than half the income derived by the State of Louisiana from state sources. During the last six-year period for which comparative figures are available, severance taxes paid to the state for the privilege of taking natural resources from the ground provided Louisiana with $383,383,900 in revenue, compared with $22,425,343 from all local sources.



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What's Happening . . .

. . . in the Industry

LPG Sales Record Another Increase

Climb is less than in recent years, but still exceeds growth of all other petroleum products.

LP-GAS SALES DURING 1957 appear to have increased by 272 million gallons—4.1 percent over the 1956 total—pushing total sales to an estimated 6,907,700,000 gallons. While this increase is lower than the LP-Gas industry has shown in recent years, it is impressive since it exceeds the estimated percentage increases in sales of all other petroleum products this year.

The figures presented in this annual report were compiled by George R. Benz, manager, Engineering department; W. F. DeVoe, manager, LP-Gas Sales, Sales department; and Paul W. Tucker, technical representative, Engineering department, all of Phillips Petroleum Co., Bartlesville, Okla. The following analysis by the authors provides an interesting insight into just what factors were involved that made this increase possible.

Domestic and Motor Fuel. It is estimated that the domestic and motor fuel market for LP-Gas in 1957 totaled 3,943,300,000 gallons. This is a 4.5 percent or 168.8 million gallon increase over 1956. The most important factor in domestic growth continues to be house heating as more people demand modern gas heat. As natural gas distribution facilities are expanded and extended some heating loads are lost, but in practically all cases the net result is a gain due to more people becoming "gas conscious." The swing to central heating was more pronounced in 1957 and "year-around weather conditioning" with gas represents a huge potential market.

Agricultural use of LPG continued to expand in spite of an extremely wet growing season and floods. Crop drying increased tremendously in many sections and offered an opportunity for many dealers to increase their summer LPG load as they make more farmers aware of its advantages. Use of LPG in flame weeding and flame cultivation continues to grow. It is estimated that sales of flame weeding equipment were up 30 percent. Use of LPG as fuel for tar and asphalt kettles, plumbers' pots, pre-heating torches and in oxy-propane cutting is becoming more widespread. It is also finding increased acceptance as fuel for portable heating devices on construction jobs.

Motor Fuel. It is estimated that 7.9 percent more LPG was used as motor fuel in 1957 than in 1956. This is an increase of 61 million gallons and makes the estimated total 834.5 million gallons.

Largest volume users of LPG motor fuel are irrigation pump engines, farm tractors and drilling rigs. Heavy rainfall during the growing season of the Great Plains states along with reduced drilling activity resulted in a substantial drop in fuel consumption for these two uses. The fact that, in spite of this drop, the total volume of LPG used for motor fuel exhibited a healthy increase testifies to the tremendous growth of other engine fuel uses.

The number of factory equipped LPG farm tractors produced in 1957 was estimated at 15,500—27 percent higher than in 1956. This increase is

Here's Where LPG Goes

1. Domestic and Motor Fuel. Advanced 4.5 percent to 3.94 billion gallons. Motor fuel shows the largest percentage gain but house heating is still the largest domestic use.

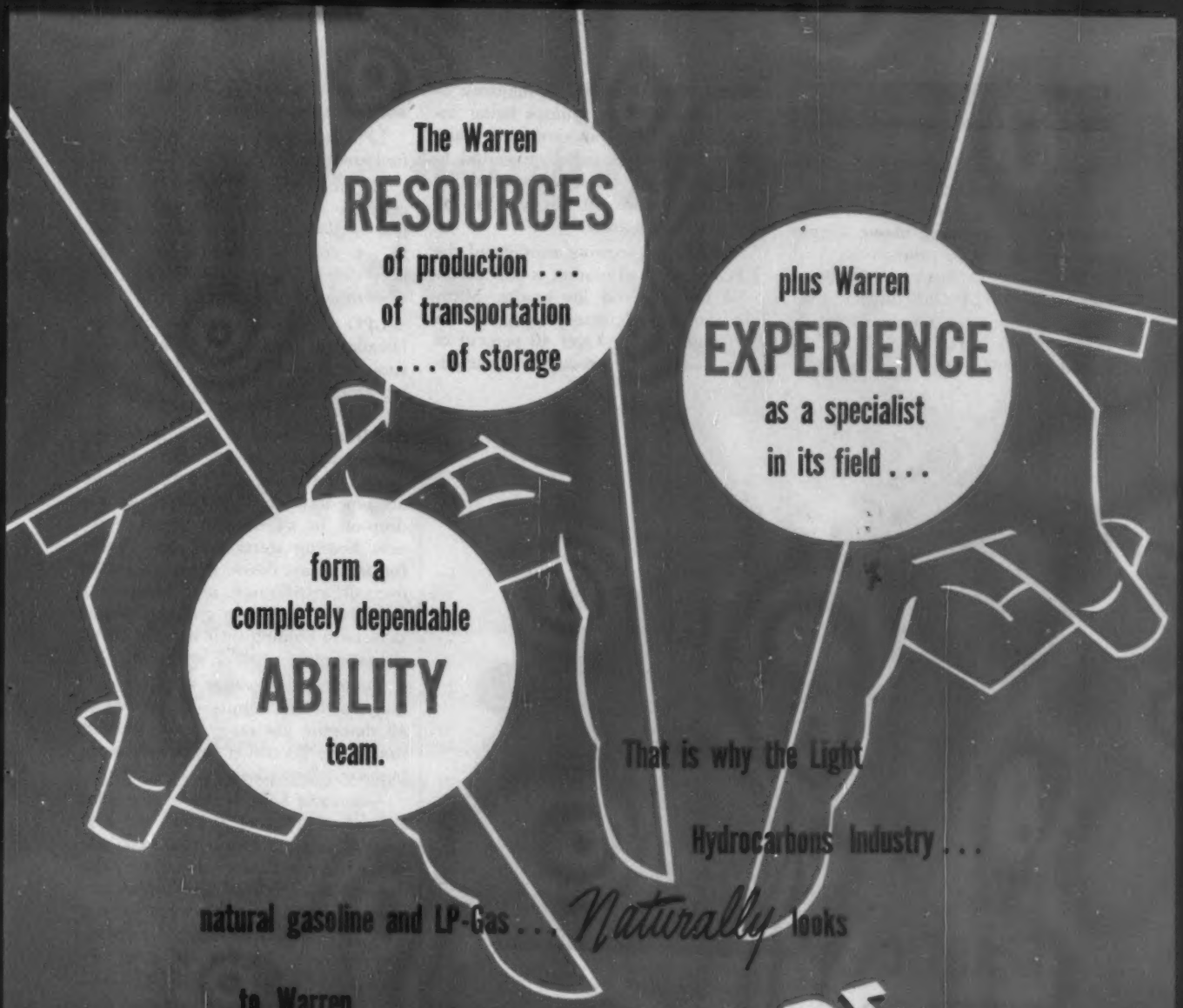
2. Industrial and Miscellaneous. Up to 1.4 percent to 668 million gallons—reflecting continued strong industrial activity.

3. Gas Manufacturing. Down 4.2 percent to 203 million gallons due to extension of natural gas pipelines and a relatively mild first quarter which reduced peak shaving demand.

4. Chemical Manufacturing. Use of LPG as feed stock for chemical plants increased by six percent to 1.67 billion gallons—indicative of the continued rapid growth of the chemical industry.

5. Synthetic Rubber. LPG used in manufacturing synthetic rubber components increased two percent to 426 million gallons as synthetic rubber continues to displace natural rubber in the total rubber market.

Gains in motor fuel and chemical use are particularly impressive. Production, storage and transportation facilities increased to supply the higher demand. Indications are that 1958 will be an even better growth year for the industry.



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particularly significant because gasoline fueled tractor production was down about 7 percent. LPG fueled tractors now represent about 5.5 percent of total tractor production.

About 45,000 farm tractors were converted to LP-Gas during 1957, bringing the total number of LPG farm tractors in the U. S. to an estimated 368,000 units.

Many New Pumps. A majority of the new irrigation pumps being installed are LPG powered and many existing units are being converted to LPG, although natural gas continues to make inroads on this load in the gas producing areas.

The fastest growing segment of the LPG motor fuel market is still industrial tractors and lift trucks. Many new units are factory-equipped for LPG motor fuel. Over 40 percent of LPG carburetor production (excluding farm tractors) is for lift trucks and industrial tractors.

LPG has nearly taken over as the fuel for cargo truck refrigeration units.

Highway vehicles fueled by LPG continue to increase although only a few of the long distance haulers have, as yet, converted their fleets. Many fleets are running comparative tests with other fuels at this time.

LPG dispensing facilities are being installed at more and more service stations to serve this rapidly expanding market.

Appliances. Sales of LPG appliances and equipment during 1957 lagged behind the highs of 1956 because we are now in a period which has seen a drop-off in all durable goods. Also, new housing starts and new family formations are down. However, in the over-all appliance and equipment field, LPG appliance and equipment sales were holding their own or above the average.

Domestic LPG range sales are estimated at 394,000 units—20 percent of all domestic gas range sales. Built-in ranges are becoming more and more popular, particularly in new homes.

Automatic LPG water heater sales are expected to be 304,200 which is over 12 percent of all automatic gas water heaters. Warm air furnace sales are estimated at 720,000 of which approximately 10 percent were for use with LP-Gas. Of the 160,000 conversion burners, 3.6 percent were expected to be for LP-Gas. Sales of LP-Gas direct heating equipment and vented recessed wall heaters should reach 405,800 units. LPG floor furnace sales are estimated at 25,500 or 27.7 percent of all gas floor furnace sales.

Industrial and Miscellaneous. LPG used in industrial and miscellaneous applications during 1957 is estimated at 668.9 million gallons—up 1.4 percent over 1956. The increase in this category was held down by the "leveling-off" trend in industrial activity. Use of LP-Gas in asphalt aggregate drying is gaining wider acceptance as highway construction increases.

Gas Manufacturing. Use of LPG by gas utilities in 1957 is estimated at 203.5 million gallons, a decrease of 4.2 percent from 1956. This decrease is due

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to expansion and extension of natural gas pipelines. Utility demand for LPG is primarily determined by the severity of the weather.

Gas distribution utilities continue to show a strong interest in underground storage facilities. Preliminary work has already started on one such mined LPG storage installation in the Great Lakes region.

Chemical Manufacture. The sale of LPG as a raw material for the manufacture of chemicals and chemical intermediates gained at a somewhat lower rate than during the previous two years, due primarily to general business conditions. However, the operation of new facilities in the Gulf Coast and western Texas area, some of which were started up in late 1956, resulted in a gain of 6 percent to a total of 1,665,500,000 gallons for the year.

Most of the increase was due to the rapid growth in polyethylene capacity, with a number of plants coming on stream during 1957. Other polyolefin plastics or elastomers received considerable attention but remained largely in the development stages.

Butadiene plants, especially those using normal butane as a feed stock, are becoming important producers of petrochemicals other than synthetic rubber components, since their operation can easily be modified to yield increased recovery of butylenes and propylenes.

Synthetic detergents used increased quantities of propylene obtained mainly from rich refinery gas streams, and the use of LPG in the production of intermediates for synthetic fibers also increased. Large volumes of LPG were used to make intermediates for the manufacture of styrene.

Nitroparaffins, acetylene, hydrogen, phenols, glycols, amines, acetones, various motor fuel and lubricating oil additives and alcohols are smaller but growing chemical products using LP-Gas components as a raw material.

A small but interesting and growing application is its use as a propellant in aerosol type containers.

Rubber Components. The use of LPG in manufacturing synthetic rubber components during 1957 is estimated as 426.5 million gallons. This is an increase of two percent over 1956. The total might be higher if it were possible to distinguish between that going into manufacturing synthetic rubber and that used as chemical feedstocks. The U. S. consumption of synthetic rubber was up about eight percent over 1956. The fact that production increased only two percent is because producers and consumers both reduced inventories during the first half of 1957. In addition, one major synthetic rubber producer was shut down for an extended period by a strike.

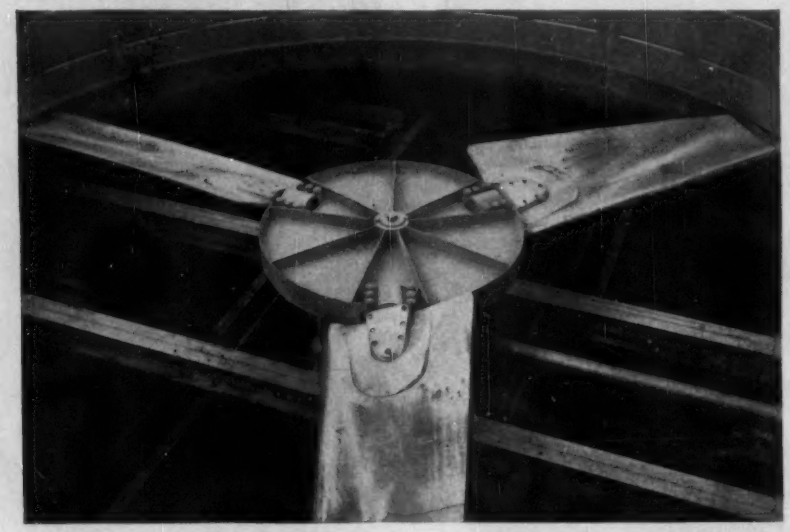
It is interesting to note that the plant capacity for making GR-S has increased nearly 55 percent in the two years since the ownership of the plants changed from the government to private industry. In 1956 the ratio of synthetic to natural was about 60:40, whereas in 1957 the ratio appears to be even better than 63:37. It is felt that synthetic rubber will continue to improve its position.

Supply. Last year saw the addition of 32 new plants with an estimated production capacity of 1.2 million gallons per day. This additional capacity along with that resulting from expansion offset the lower production from some plants, part of which was due to curtailed allowables. It is now estimated that approximately 23 new plants having a production capacity of nearly 1.5 million gallons per day will be added in 1958. A recent National Petroleum Council report indicated that the LPG production could be vastly increased in the event of a national emergency—assuming no proration of crude oil and natural gas production.

LPG storage capacity increased. It is estimated that the available underground storage capacity is now close to 1.4 billion gallons, and there is now an additional 400 million gallons planned or under construction.

A new aspect of LPG storage capacity was introduced. This is the miscible displacement of crude oil which involves the injection of LPG followed by lean gas and in some cases subsequently by water. While it is referred to here as another type of storage, it can be considered another use in that the LP-Gas is essentially "stored" underground while used in this process. It is not known what the recovery will be, but in most instances it will be necessary to reprocess it before it will be marketable. The volume involved is indefinite but several companies now have projects underway and with the interest currently being shown it could become an important factor in the LPG storage and supply picture.

Transportation. Expansion of LPG transportation facilities continued during 1957. One new interstate LPG pipeline went into operation in addition to several short pipe-



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Hartzite plastic fan blades practically eliminate fan blade replacement problems in cooling towers and heat exchangers. They effectively resist corrosion, abrasion and vibration. Hartzite blades are constructed stronger to last longer. These tough, rugged blades are made of a phenolic-impregnated fabric-base material — solid construction . . . won't scale, won't peel . . . means low maintenance.

The hub section is dynamically balanced . . . solidly constructed of welded steel . . . with gussets for extra strength and increased safety.

Hartzite plastic fans are available in sizes from 10′ to 22′. Hubs are designed for 2, 3, 4 or 6 blade assemblies.

Find out more about how Hartzell helps you to cut cooling tower maintenance costs. Mail the coupon below for new bulletin A111B, "Cooling Tower and Heat Exchanger Fans".

HARTZELL PROPELLER FAN CO.
Division of Castle Hills Corp.

709 THOMAS BLVD., PIQUA, OHIO

Please send me a copy of Bulletin A-111B.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____

the most ECONOMICAL maintenance is PREVENTIVE maintenance

TWO OF THE MOST EFFECTIVE PREVENTIVE MAINTENANCE MEASURES ARE:

1 *98% to 100% SALT REMOVAL with Tretolite Chemical Desalting*

Tretolite Desalting prevents salts, solids, trace metals and other impurities from entering the refinery stream. It prevents salt plugging and fouling in condensers, exchangers and towers, reducing clean-outs and tube rattling to minimum. Tretolite Desalting is an automatic, all-chemical process that consistently delivers salt removals in the 98% to 100% range.

2 *EFFICIENT CORROSION PREVENTION with Kontol Corrosion Inhibitors*

Kontol Corrosion Inhibitors prevent internal corrosion and hydrogen blistering and help to eliminate scale and fouling difficulties. Kontols are readily adsorbed from hydrocarbon solutions at metal surfaces to form a tough impervious film. In addition to their inhibiting properties, the Kontols are powerful detergents which clean and de-foul refinery equipment.

Ask the man in the red car

The Tretolite Service Engineer is always on call to assist you in your maintenance and processing problems.

AR-58-1

TRETOLITE COMPANY

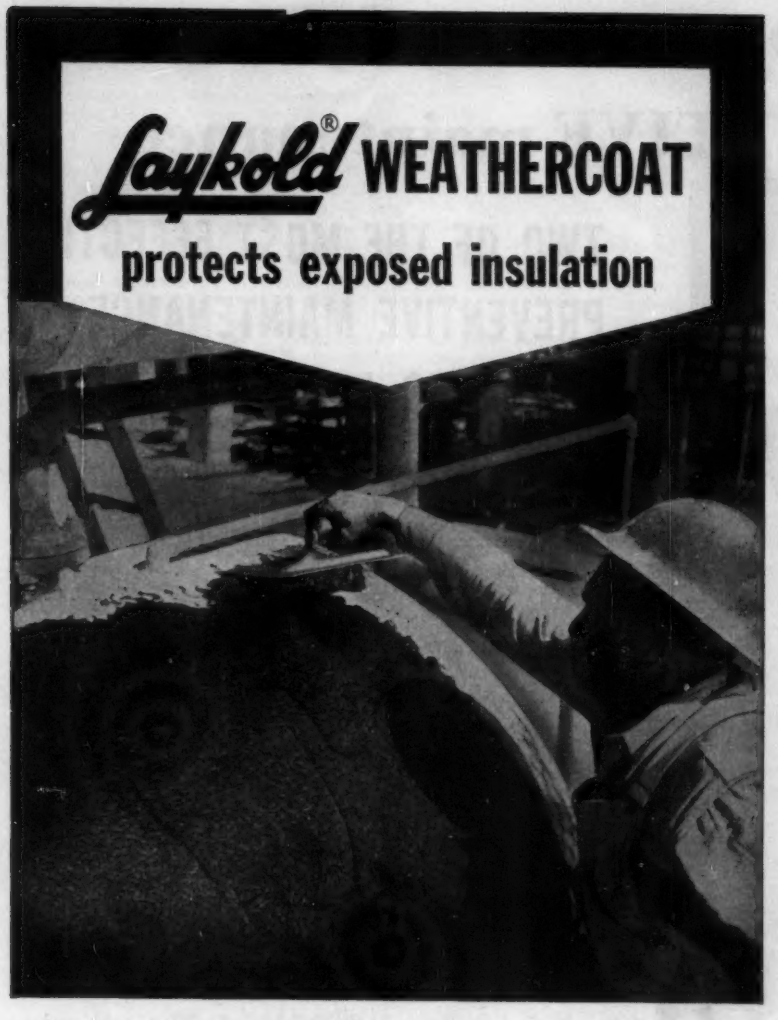
Divisions of Petrolite Corporation

369 MARSHALL AVENUE, ST. LOUIS 19, MISSOURI
5515 TELEGRAPH ROAD, LOS ANGELES 22, CALIFORNIA

Chemicals and Services for the Petroleum Industry

DESALTING • CORROSION INHIBITING • DEMULSIFICATION • SCALE PREVENTION
WATER DE-OILING • METAL DEACTIVATION ADDITIVES

For more data on advertised products, use Readers' Service Cards, last page.



INSULATION on towers, tanks and exchangers must be kept DRY. If moisture gets through, the efficiency drops.

Modern refinery and plant design places many major insulated vessels "in the open." You can maintain the efficiency of your insulation with easy-to-apply Laykold Weathercoat.

Weathercoat is a fibrated asphalt-base material of easy troweling consistency that dries to a black, remarkably tough and tenacious coating. A majority of the leading refineries are regular users of Weathercoat.

A new product: Mastic Weathercoat, a bodied material, for use wherever economy demands the application of a *single,* thick layer.

Write today for free illustrated brochure, entitled "Laykold Weathercoat for Insulation Protection."

American Bitumuls & Asphalt Company

320 Market St., San Francisco 20, California
Baltimore 3, Md. — St. Louis 17, Mo. — Perth Amboy, N. J.
Mobile, Ala. — San Juan 23, P.R. — Cincinnati 38, Ohio
Inglewood, Calif. — Oakland 1, Calif. — Tucson, Ariz.
Portland 7, Ore.

What's Happening. . .

lines to carry feedstock to chemical plants. Several pipelines went into operation carrying natural gas liquids, one pipeline is being considered for products services (including LP-Gas), and two railroads have undertaken a joint study to determine the feasibility of constructing an LP-Gas pipeline along their right-of-way.

Safety Developments. The National Fire Protection Association Standard No. 58 covering the Storage and Handling of Liquefied Petroleum Gases, was again revised, as was NFPA Pamphlet No. 59, to keep pace with new developments in equipment and safe operating techniques in a continuing effort to improve the already enviable safe record. Additionally, the new API bulletin No. 2510 covering the design and construction of LP-Gas storage installations in refineries, natural gasoline plants and marine and pipeline terminals was completed and issued.

Outlook. While the LPG industry exhibited a better growth than the petroleum industry in general and the nation's economy as a whole, it can do better. There are still many potential "load builders" to be developed. The industry winter to summer has been increasing. By pushing summer "load builders" dealers will be in a better position to capture and expand the househeating load. Gas air conditioning still represents a tremendous potential load yet to be tapped.

By developing new fuel loads, utilizing modern business practices, and by effective selling methods the industry should do even better in 1958.

Octanes Show Yearly Gain

Gasoline on sale at service stations in December showed national weighted averages of 98.4 octane number for premium and 91.1 octane number for regular, according to the latest monthly survey compiled by Ethyl Corp.

The premium gasoline average was unchanged from November while the regular gasoline average was 0.1 octane number higher than a month ago.

For companies marketing more than one grade of premium, the survey showed a range of 100.3 to 102.3 octane number for the highest grade, on the basis of 38 samples in 19 cities.

For 1957 as a whole, the premium average gained 1.1 octane number and the regular average gained 0.7 octane number.

Average tetraethyl lead contents in December were 2.51 ml. per gallon of premium gasoline and 2.02 ml. per gallon of regular gasoline.

Heat Exchanger Standards Needed by Chem Industry

An annual savings of $3.9 million to the chemical industry alone is possible if national standards are developed for heat exchangers, it was revealed at a conference of manufacturers, users and others concerned, at the offices of the American Standards Association.

This statement was made by J. G. Henderson, chairman of the Chemical Industry Advisory Board, which was set up at the request of the industry, in presenting a report prepared by the board at the request of the Manufacturing Chemists Association.

The conference recommended that the

For more data on advertised products, use Readers' Service Cards, last page.

Send for this important brochure!

Learn how a versatile Jupiter® gas turbine engine can help solve your power problems

SOLAR'S 500 HP JUPITER gas turbine offers a radical new power concept for forward-looking businesses. One of the simplest of all heat engines, it is especially suited to applications where there are interrelated requirements for shaft power, processing heat and compressed air. New users praise its high power-to-weight ratio, its instant starting under severe temperature extremes, its low maintenance requirements and its ability to burn a wide variety of fuels.

Solar has prepared a colorful 24-page booklet giving full details about the Jupiter. It contains all of the information necessary to acquaint you with the many advantages of this exciting new engine—and it's yours for the asking. Learn how this power plant of the future can go to work for you—*today!* Write to Dept. D-137, Solar Aircraft Company, San Diego 12, California. *Designers, developers and manufacturers of gas turbines, expansion joints and aircraft engine, airframe and missile components.*

SOLAR
AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

FOR NEW JUPITER BROCHURE, MAIL TO:
Dept. D-137, Solar Aircraft Company, San Diego 12, California.

NAME_____
TITLE_____
COMPANY_____
ADDRESS_____
CITY_____

ENGINEERS WANTED. *Unlimited opportunities, challenging projects, good living with Solar! Write for new brochure.*

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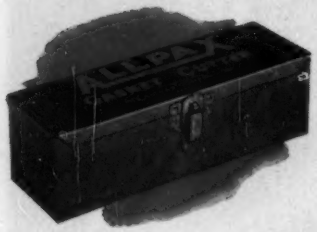
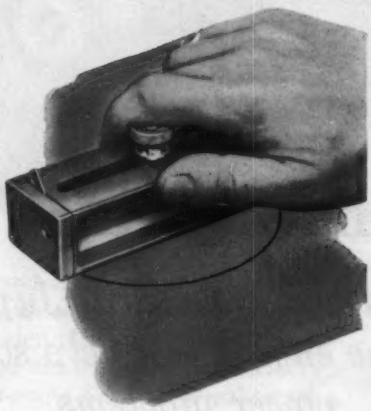
with the ALLPAX Gasket Cutter

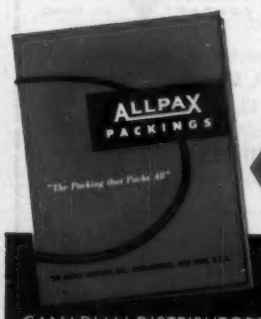


Maintenance men from Maine to Mexico have found that they can save hours of costly "down time" with this handy kit. Accurate gaskets can be cut quickly and easily by following a few simple directions—as easily as drawing circles with a compass.

The Allpax Gasket Cutter uses the "ironing principle" to hold material flat during the sweep of the cut, and prevents buckling and tearing common with make-shift devices. All materials in general use as gaskets may be cut to diameters ranging from ¼" to 36" using the popular No. 3 kit. Other kits available for maximum diameters of 12, 24, 48 and 60 inches. Allpax Gasket Cutters and accessory tools are neatly packaged in the permanent metal tool case shown above. An 18" square cutting board is supplied with each kit.



See your local dealer for additional information on the Allpax gasket cutter and our complete line of gasket materials.



ALLPAX

"The Packing that Packs All"

SEND FOR OUR CATALOG — TODAY!

A complete line of packing, tools, gasket materials
Distributors in principal cities

THE ALLPAX COMPANY, INC.
160 Jefferson Ave., Mamaroneck, N. Y.
CANADIAN DISTRIBUTORS: Albion Asbestos Packings Ltd., Montreal 18, Quebec

What's Happening . . .

American Standards Association establish a project for developing American Standards covering heat exchangers. Such a project would cover shell and tube heat exchangers of the following types: Fixed tube sheet with or without a shell expansion joint, U-tube, internal floating head, outside packed floating head and the kettle-type reboiler.

New Ethyl Operation

Ethyl Corp. has put into operation a new experimental installation for mixing "Ethyl" fluid and gasoline. The experimental mixing plant, located at Ethyl's Houston manufacturing plant, will be utilized for intensive studies, on behalf of refiners, of mixing plant methods and equipment.

The knowledge gained from the extensive studies will be used by Ethyl product service engineers in their work of helping refiners blend "Ethyl" fluid with gasoline with maximum efficiency and safety. The installation will also provide facilities for training personnel.

Columbia Forms Subsidiary

Formation of Columbia Hydrocarbon Corp., a new wholly owned subsidiary, has has been announced by George S. Young, president of The Columbia Gas System, Inc.

Columbia Hydrocarbons will own and operate a fractionation plant at Siloam, Ky., across the Ohio River from Portsmouth, Ohio, and a 35-mile pipeline which will transport a mixed stream of hydrocarbons extracted from natural gas at Kenova, W. Va. The Kenova extraction plant is now being built by United Fuel Gas Co., a major operating company of the Columbia Gas System.

Fire Cripples Ingram Plant

Ingram Oil & Refining's 18,000 bpd refinery at New Orleans will be down for at least 90 days as result of fire which broke out last month in run-down tank and blending section of plant. In order to meet its contractual obligation, the company plans to buy products from other refiners until the refinery is back on stream.

Fire destroyed about 100,000 barrels of products, most of which was gasoline; all run-down tanks, and most blending tanks. It also burned out most motors and lines. One employee was killed.

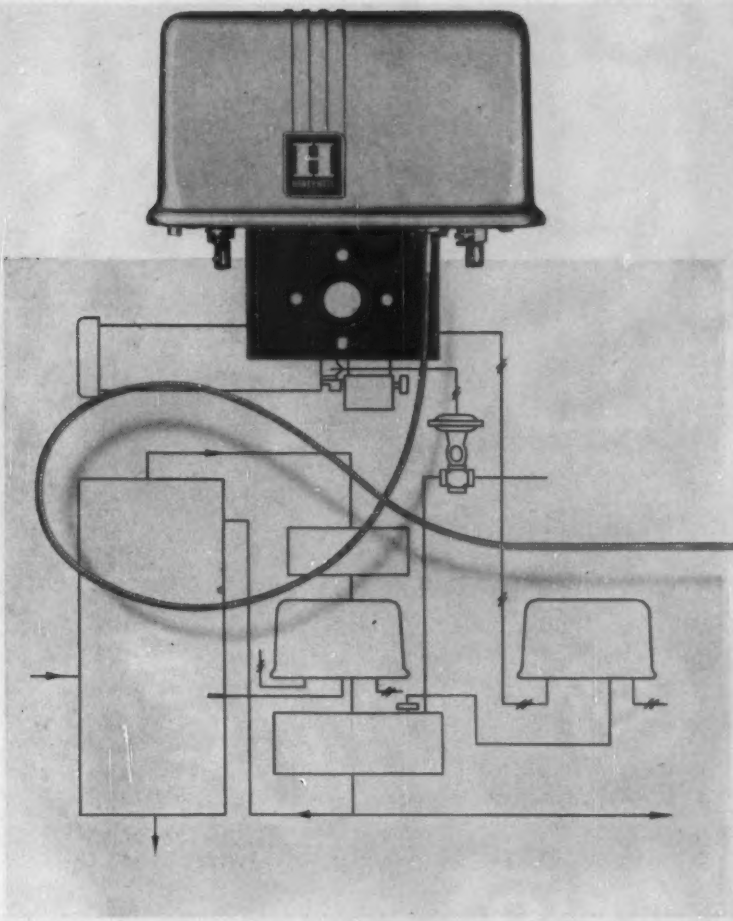
Oil Congress to Draw 5000

Plans are under way for holding the Fifth World Petroleum Congress in the Coliseum in New York City in June, 1959, commemorating the centennial of the discovery of oil in Pennsylvania. The Congress will include a symposium on the utilization of nuclear energy in the oil industry.

About 5000 persons are expected to attend including 1000 from abroad. The Fourth World Petroleum Congress met at Rome, Italy, in 1955.

Between 70 and 80 technical sessions are expected to be held. They are to be divided into the following nine sections: (1) geology and geophysics, (2) drilling and production, (3) oil processes and refining, (4) chemicals from petroleum products, (5) composition, analysis, and testing, (6) utilization of petroleum products, (7) engineering, equipment, and

For more data on advertised products, use Readers' Service Cards, last page.



TEMPERATURE SENSING ELEMENT has small bulb for fast response. Either plain or coiled bulbs are standard, with or without union connections. For food processing applications, bulb is available with union connection for Type 3A4 sanitary fitting.

PRESSURE SENSING ELEMENT—a sealed volumetric pressure unit with stainless steel diaphragm and flange protects the transmitter from corrosive material, and damps line pulsations.

One basic TEL-O-SET transmitter serves all applications

- Measures temperature, gage pressure or absolute pressure.
- Requires only one thermal system and one pressure system for all ranges. Changeover from temperature to pressure measurement is extremely simple.
- Span can be shifted to cover any part of the overall transmitter range—from 40 to 600 psi, or from –375 to 1000°F—*without changing or adding parts.*
- Equally accurate at small spans of 20 psi and 50°F or at wide spans of 150 psi and 400°F.
- High-speed response to temperature or pressure changes permits control within close tolerances.
- Ambient temperature and pressure compensated. Vibration resistant.

REFERENCE DATA: Write for Specification S1003-1

Get complete details on *Tel-O-Set* transmitters . . . and related *Tel-O-Set* miniature indicators, recorders and controllers . . . from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Products Group*, Brown Instruments, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

First in Controls

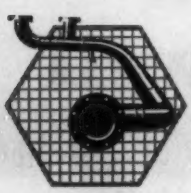
2 SURE WAYS TO REDUCE SPECIALIZED PIPING COSTS... by PIPE FABRICATORS, Inc.

First, you save simply because it's our business to fabricate big, small and difficult piping assemblies at less cost!

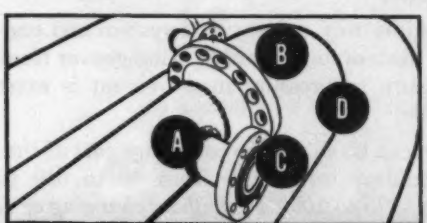
We have the complete facilities it takes for proper cutting, welding, bending, heat treating *and* testing. Piping materials and components of all kinds are right at our back door. And we have the experience to get the job done right without delay. *Very often we can suggest ways to cut corners for further savings!*

Second, Pipe Fabricators, Inc. can assure you even greater savings in more simplified field installation *plus* more dependable on-the-job performance.

Tell us your requirements.



PIPE FABRICATORS, Inc.
504 W. 145th Street
East Chicago, Indiana



THESE ARE THE PROBLEMS WE CAN SOLVE FOR YOU...

- **A** Controlled Welding of all alloys to assure safer joints.
- **B** Precise cutting and bending of all sizes of piping and tubing.
- **C** Proper alignment to simplify your field assembly.
- **D** Fast procurement of all materials including chrome, aluminum, stainless steel, brass, copper.

PLUS pretesting of all components and sub-assemblies.

For more data on advertised products, use Readers' Service Cards, last page.

materials, (8) transportation, distribution, marketing, and (9) operations research, statistics, and education. About 200 technical papers will be presented.

Headquarters of Fifth World Petroleum Congress, Inc., is 527 Madison Avenue, New York 22.

Oil Computer Use Expands

Purchase of the first digital computer for fully automatic control of a petroleum refining process was made known last month by J. S. Worden, vice president in charge of The Texas Co.'s Refining department. The computer will control the petroleum refining process on a polymerization unit at Texaco's Port Arthur, Texas, refinery.

It is the first digital computer engineered specifically for automatic control of industrial processes such as oil refining. It is also the first such machine which can be connected directly to conventional process instruments and controllers.

Another firm, Arthur McKee & Co., also announced last month that an electronic computer is being used in the engineering, designing and construction of petroleum refineries, chemical plants and related facilities.

Its importance was demonstrated to 35 petroleum engineers, representing refining and chemical companies who were guests of McKee's Petroleum Division at a one-day symposium.

The symposium covered computer applications in the solution of engineering design problems, and a discussion of plans for broadening the use of the machine.

Other technical sessions concentrated on such topics as flash and condensation calculations, short cut fractionation, plate to plate fractionation calculation, tray hydraulics, fractionating absorber, box cooler, line sizing, pipe stress analysis and structural programs.

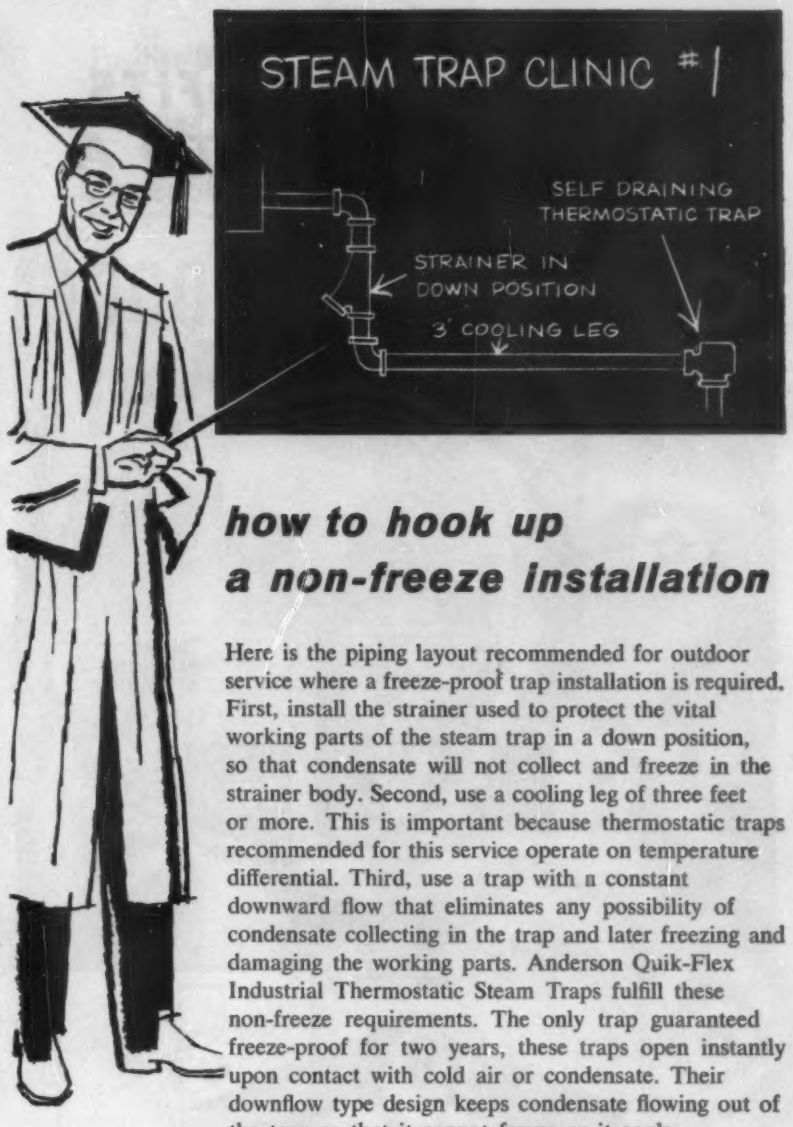
OCAW, Imperial Oil Agree

Strike ending agreement between management of Imperial Oil's Ioco refinery and Oil, Chemical & Atomic Workers includes $144 lump sum to each employee in lieu of wage retroactivity to March 16, and increases in shift differentials to 8c hour.

It also provides, said C. L. Barber, president of OCAW local for:

1. Double time for overtime after first four hours at time-and-one-half.
2. Four weeks of vacation after 20 years of service, three weeks after 10 years.
3. More statutory holidays, and day off with pay for every statutory holiday worked.
4. Payment of $2 in lieu of lunch when employee works 10 hours or more.
5. Irrevocable check-off of union dues.
6. Fourteen classification and category adjustments.

NOW!
Turn the Page
and read
"Changing Times"



how to hook up a non-freeze installation

Here is the piping layout recommended for outdoor service where a freeze-proof trap installation is required. First, install the strainer used to protect the vital working parts of the steam trap in a down position, so that condensate will not collect and freeze in the strainer body. Second, use a cooling leg of three feet or more. This is important because thermostatic traps recommended for this service operate on temperature differential. Third, use a trap with a constant downward flow that eliminates any possibility of condensate collecting in the trap and later freezing and damaging the working parts. Anderson Quik-Flex Industrial Thermostatic Steam Traps fulfill these non-freeze requirements. The only trap guaranteed freeze-proof for two years, these traps open instantly upon contact with cold air or condensate. Their downflow type design keeps condensate flowing out of the trap so that it cannot freeze as it cools.
Mail coupon for complete details.

ANDERSON *QUIK-FLEX* STEAM TRAPS

THE V. D. ANDERSON COMPANY
division of International Basic Economy Corporation
1953 West 96th Street • Cleveland 2, Ohio

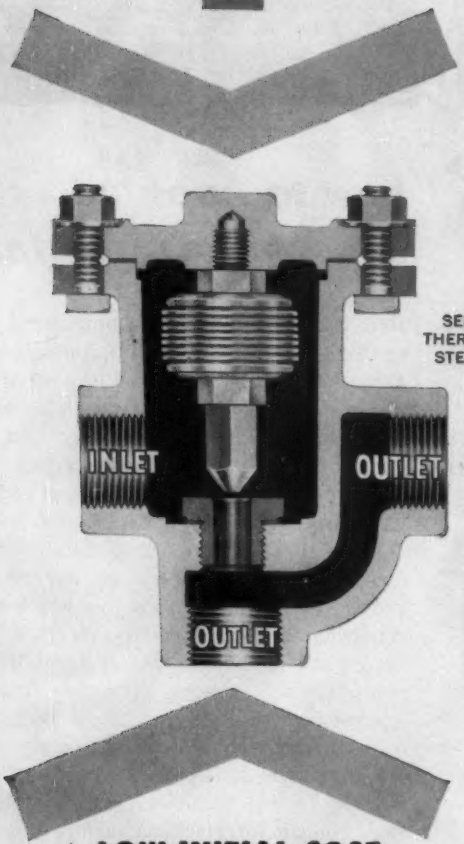
Please send additional information on Anderson freeze-proof Quik-Flex Thermostatic Steam Traps.

Name _____ *Title* _____
Company _____
Address _____
City _____ *Zone* ____ *State* _____

Guaranteed Not to Freeze

For more data on advertised products, use Readers' Service Cards, last page.

Clark FITS TO A "T"



★ LOW INITIAL COST
★ EASY TO INSTALL
★ LOW MAINTENANCE
★ MINIMUM INVENTORY

Ask Your Distributor For These CLARK Fluid Controls

Inverted Bucket Traps	Venting Traps	Pressure Regulators
Open Bucket Traps	Thermostatic Traps	Y-Type Strainers
Float Traps	Vacuum Traps	Pressure Reducing Valves

STANDARDIZE ON THE COMPLETE CLARK LINE

ASK YOUR DISTRIBUTOR OR WRITE DIRECT FOR FREE BROCHURES ON CLARK FLUID CONTROLS

THE Clark MANUFACTURING COMPANY
1839 East 38th St. • Cleveland 14, Ohio

–Changing Times–

Standard Vacuum **lost its fight for compensation from U. S. government** for use of company property in Japan by military occupation forces. **U. S. Supreme Court refused to consider Stanvac's appeal** from ruling last summer by U. S. Court of Claims, which dismissed the claim.

Aramco produced its 3 billionth barrel of oil last month. This makes Saudi Arabia second nation in Middle East and fifth in world to achieve this mark.

First of several overseas shipments of **American-made butadiene is now enroute by barge** from Port Neches, Texas, to Ravenna, Italy. Goodrich-Gulf Chemicals said the 2200 ton cargo will require 35 days travel.

Estimated 1956 **retail sales by gasoline service stations totaled $13.7 million. This was an 11 percent increase** over 1955 as compared with just a 3 percent for all U. S. retail sales.

Bakelite Co., Division of Union Carbide Corp., **has withdrawn from the sale and manufacture of polyester resins.** Company will, however, continue in epoxy and phenolic fields.

World's brightest light has been turned on atop a 206-foot cat cracker at Wilshire Oil's Santa Fe Springs, Calif., refinery. Powerful light generates five hundred million candle power.

Esso Research and Engineering has **moved its executive offices** from New York City to Linden, N. J.

National Distillers and Chemical Corp. has acquired Panhandle Eastern Pipe Line's 40 percent minority interest in National Petro-Chemicals Corp. National Petro, which will be a 100 percent subsidiary of National Distillers, owns a large petrochemical plant in Tuscola, Ill., and will build a polyethylene plant in Houston.

Cosden Petroleum's 7000 bpd plant at Hawley, Texas, will be down for at least all 1958 while study is made of possibly converting it to special products plant. **Fifty percent cutback in military avgas contract is reason** Cosden says. Refinery was acquired little over year ago from Onyx Refining.

Medallion Petroleums, Ltd., has taken over operations and management of New Gas Exploration, Ltd., through acquisition of stock interests of various other companies. Those include Canadian Atlantic Oil, and Pacific Petroleums.

Shell Oil has developed **new class of greases for high temperature,** high speed application in missiles and supersonic planes. New grease will **withstand temperature up to 600 F., and will protect metal at speeds of 30,000 rpm's.**

For more data on advertised products, use Readers' Service Cards, last page.

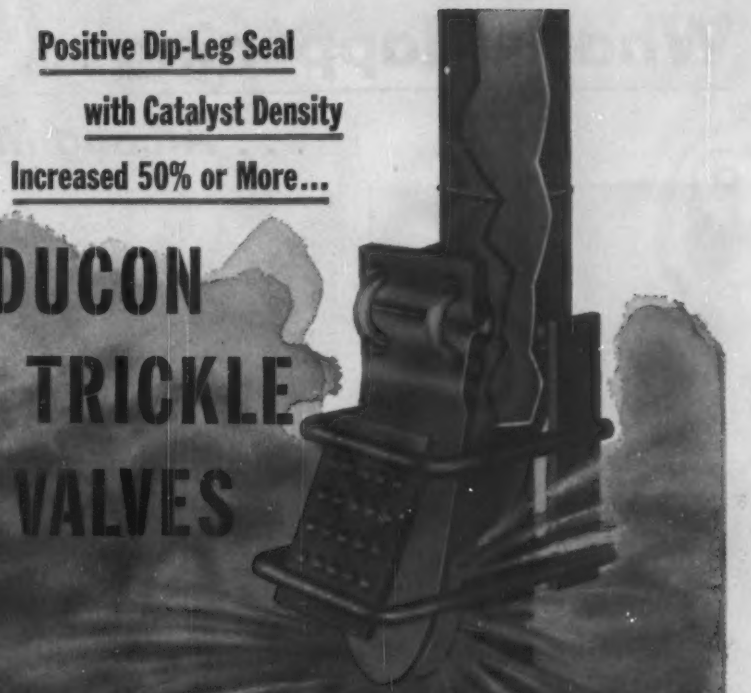
MEETINGS CALENDAR

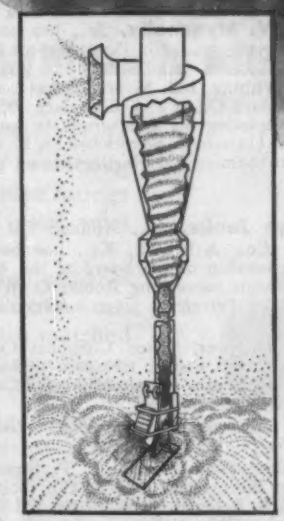
1958	
JAN.	
20–21	Compressed Gas Association, Inc., 45th Annual Meeting, Waldorf-Astoria, New York.
20–24	National Fire Protection Association, Committee Week, Manhattan Hotel, New York City.
FEB.	
2– 7	ASTM Committee D-2 Meeting, Rice Hotel, Houston.
2– 8	ASTM Committee D-2, Petroleum Products and Lubricants Meeting, Rice Hotel, Houston.
3	Central Simulation Council, Monsanto Chemical Co., General Offices, St. Louis, Mo.
3– 4	Instrument Society of America National Conference on Progress and Trends in Chemical and Petroleum Instrumentation, Wilmington, Delaware.
5– 6	Western Petroleum Refiners Association, Gulf Coast Regional Technical-Industrial Relations Meeting, Ben Milam Hotel, Houston.
10–14	American Society for Testing Materials, Committee Week, Hotel Statler, St. Louis, Mo.
12–14	API Division of Marketing, Marketing Research Committee, Biltmore Hotel, New York City.
27–28	API Division of Marketing, Lubrication Committee Meeting, Sheraton-Cadillac Hotel, Detroit.
MAR.	
3– 4	Society of Petroleum Engineers of AIME, 4th Annual Joint Meeting, Cosmopolitan Hotel, Denver.
5– 7	API Oil Information Committee, St. Francis Hotel, San Francisco.
17–21	Fourth Nuclear Engineering and Science Conference, Chicago International Amphitheatre.
17–21	National Association of Corrosion Engineers, National Meeting, Civic Auditorium, San Francisco.
24–26	Western Petroleum Refiners Association, 46th Annual Meeting, Hilton Hotel, San Antonio, Texas.
APRIL	
13–18	American Chemical Society, 133rd National Meeting, San Francisco, Site Unreported.
14–18	American Welding Society, Annual Technical Meeting and Show, Hotel Statler, St. Louis, Mo.
15–17	Southwestern Gas Measurement Short Course, University of Oklahoma.
17–18	Society of Petroleum Engineers of AIME, La.-Ark., East Texas and Miss. Petroleum Sections, Gas Technology Symposium, Site Unreported.
20–23	American Institute of Chemical Engineers, Montreal, Canada.
22–24	American Society of Lubrication Engineers Annual Meeting, Cleveland, Site Unreported.
27–29	Independent Petroleum Association of America, Mid-year Meeting, Hotel Sherman, Chicago.
MAY	
5– 7	Purdue Industrial Waste Conference, Purdue University Memorial Union Building, Lafayette, Ind.
5– 9	API Safety and Fire Protection Committee, 11th Midyear Meeting, Cosmopolitan Hotel, Denver.
12–14	Analysis Instrumentation Division of the Instrument Society of America, Annual Symposium, Shamrock Hilton Hotel, Houston.
12–15	API Division of Refining, Midyear Meeting, Statler Hotel, Los Angeles.
25–29	API Pollution Control Association, Annual Meeting, Sheraton Hotel, Philadelphia.

Use Readers' Service Postcard for More Information on Advertised Products

Positive Dip-Leg Seal with Catalyst Density Increased 50% or More...

DUCON TRICKLE VALVES





PATENTS PENDING

Ducon Trickle Valves provide greater stability of cyclone operation by minimizing start-up and upset catalyst losses. Increased dip-leg seal catalyst density permits greater thru-put without additional dip-leg length and vessel height. With hundreds of Ducon Trickle Valves in service, the petroleum refinery industry itself has proved their unsurpassed dependability for continuous, trouble-free operation.

Write for details now on Ducon Type CA Trickle Valves—**the first dip-leg seals with approval for fluid catalytic cracking plants.**

Ask for Descriptive Bulletin No. CV-2506

the name in DUst CONtrol

THE Ducon COMPANY INC.

147 EAST SECOND STREET • MINEOLA, L. I., NEW YORK

CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES

What's Happening . . . .

. . . *Among Men* in the Industry

Denning

Alliston

Andrews

McMillan

W. G. Denning has been promoted to section head, **J. W. Alliston, J. M. Andrews** and **K. K. McMillin,** to technical specialists, and **C. L. Umholtz** to senior chemical engineer of Humble Oil & Refining Co.'s Baytown, Texas, refinery Technical Service division.

Umholtz

Denning heads the catalytic cracking section of which Andrews and McMillin are members. This section is responsible for maintaining operation of the refinery's two catalytic cracking units.

Andrews is engaged in technical studies involving theoretical and developmental work, and McMillin is concerned primarily with developing catalytic cracking correlations and calculation procedures for highspeed elctronic data processing machines.

Alliston and Umholtz are at present serving in training assignments in Humble's executive development program, Alliston as head of the solvents section in Technical Service division, and Umholtz as foreman of the refinery's light oil treating operations.

All of these men are chemical engineers, Denning holds a B.S. degree from Georgia Institute of Technology; Alliston and Andrews, B.S. degrees from Texas A & M; and McMillin and Umholtz, B.S., M.S., and Ph.D. degrees from The University of Texas.

Dr. L. W. Burdett has been promoted to senior section leader at Union Oil Co., of California's Research Center, Brea, Calif., according to an announcement by **Fred L. Hartley,** vice president of research.

Dr. James E. Seebold will fill the new position of director of development; **Dr. Arthur P. Lien** will become director of petroleum research, and **Dr. Nathan Fragen** will become director of chemicals research and development for Standard Oil Co. (Indiana).

The three directors will report to **Dr. Philip C. White** who continues as manager of research.

The areas of responsibility that are being divided among the three new directors previously were combined under a single director of research. This post has been held by **Dr. T. H. Rogers** whose retirement was announced recently.

In additional changes, **Dr. Earnest W. Thiele** and **Bernard H. Shoemaker** will become research coordinators reporting to Dr. White. **Dr. E. W. Adams** will be administrative director of the Whiting, Ind., laboratories. **Carl E. Johnson,** chemicals research, and **Henry Marchman,** chemicals development, will become division directors reporting to Dr. Fragen.

Dr. B. D. Thomas, scientist and research administrator, has been named to the presidency of Battelle Memorial Institute to succeed **Dr. Clyde Williams,** whose retirement was announced recently.

Active head of Battelle since being named director a year ago, Dr. Thomas has been a member of the Battelle organization for many years. He joined the staff as a research engineer in 1934, was appointed assistant director in 1942, and vice president in July, 1955.

Ralph W. Myerholtz, Jr., has been named a group leader in the chemicals research division of Standard Oil Co. (Indiana) at Whiting, Ind. Myerholtz has been with Standard Oil as a chemist since 1954. After completing his undergraduate work at Purdue University, he received his Ph.D. degree in chemistry at Northwestern University.

D. Hugh Jenks, Jr., Ashland Oil & Refining Co., Ashland, Ky., has been elected chairman of the board of the Asphalt Institute succeeding **Robert O. Wilson,** Cosden Petroleum Corp., Arlington, Texas.

J. J. Tumpeer, Witco Chemical Co., New York, was named treasurer to succeed **G. R. Christie,** Socony Mobil Oil Co., N. Y., retiring.

Other members of the executive committee were elected as follows:

East Coast-Gulf division: **L. P. Street,** American Bitumuls & Asphalt Co., Baltimore,and **R. B. Lewis,** Shell Oil Co., N. Y.; Great Lakes-Ohio Valley division; **P. C. Doyle,** Standard Oil Co. of Ohio, Cleveland, and **J. S. Van Pelt,** Berry Refining Co., Chicago; Midwest division: **F. E. Widger,** The Texas Co., Chicago, and **E. M. Stone,** Empire Petroleum Co., Denver; Southwest division: **J. W. Lackey,** Malco Refineries Inc., Roswell, N. M., and **A. G. Finney, Jr.,** Houston; Pacific Coast division; **E. J. Barnes,** Macmillan Petroleum Corp., Los Angeles, and **H. D. Webb,** Envoy Petroleum Co., Long Beach, Calif.

Hugh L. Hemmingway has been appointed director of research for the Pure Oil Company, it is announced by **Robert L. Milligan,** president. Mr. Hemmingway will direct the activities of the company's Research Center at Crystal Lake, Ill., which will become his headquarters. **C. M. Ridgway** will continue as manager of the center.

Mr. Hemmingway, formerly general manager of the marketing division's sales-service departments, has been closely associated with Pure's research activities since joining the company in 1944. A mechanical engineer, he is a former president of the National Lubricating Grease Institute.

Dr. Leslie M. Addison has been appointed head of the newly-created personnel section at the Esso Research Laboratories, Baton Rouge, La. He was advanced from his post as assistant section head of catalytic research.

Dr. Addison earned a B.S. degree in chemistry from Millsaps College. In 1941 he earned an M.S. degree in chemistry from the University of North Carolina and a Ph.D. degree in chemistry from Purdue in 1950.

Dr. Addison began his career at the Esso Research Laboratories after finishing at the University of North Carolina. He took a leave of absence to serve two years in the Navy and to further his education.

The major part of his scientific career has been devoted to petroleum analytical research and catalytic processing. He has contributed research articles to a number of technical publications.

Joseph C. Weaver, Jr., has been named associate director of the Research and Development department of American Oil Co., Texas City. Weaver was formerly technical director of the Amoco Chemicals plant at Brownsville, Texas, which was recently closed.

Weaver

In 1947 he joined Stanolind Oil and Gas Co., which operated the Brownsville plant before the creation of Amoco Chemicals. He started as a chemical engineer assigned to the Research department.

Weaver is a 1935 graduate of the University of Alabama where he obtained a B.S. degree in chemical engineering. He also received the professional chemical engineering degree from that institution in 1957.

Edwin Singer, president of Caribbean Refining Co., San Juan, Puerto Rico, announced that **Guillermo Rodriguez,** of San Juan, has been named president and a director of Caribbean Refining Co. Rodriguez resigned as president of the Puerto Rico Government Development Bank.

Rodriguez, 43, was elected president of the Puerto Rico Government Development

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Men in the Industry . . .

Bank in 1953. Prior to that, from 1950 to 1953, he was president of the Puerto Rico Industrial Development Co., and has also served as president of other Puerto Rican government public corporations. Before his entry into public service, he was in private business.

Singer, who has served as president of Caribbean Refining since its inception in 1953, will become chairman of the board. **Walter Nelson,** who has served as Caribbean's plant manager since 1955, will become vice president of the company and **Gene Case,** presently operating superintendent, will become assistant vice president—manufacturing.

W. C. Atherton, H. C. Ball, C. A. Deveny, Jr., and **C. B. Fletcher** have been promoted to senior mechanical engineers in Engineering division at Humble Oil & Refining Co.'s Baytown, Texas, refinery. Atherton and Deveny are engaged in maintenance engineering and inspection work in the cracking and polymerization group, and Ball and Fletcher handle design engineering in the Division's Design Department.

Each of these men hold the B.S. degree in mechanical engineering, Atherton from Alabama Polytechnic, Ball and Fletcher from Texas A & M, and Deveny from Texas University.

William F. Kenney, New York, vice president and general counsel of Shell Oil Co., was re-elected chairman of the American Petroleum Industries Committee of the American Petroleum Institute.

Re-elected as vice chairman at the organization's annual election meeting was **Henry L. O'Brien,** New York, general counsel, and a director of Cities Service Company.

W. R. Huber, director of public relations for Gulf Oil Corp., Pittsburgh, has been named director of the petroleum industry's Centennial celebration in 1959. Huber, who has been given leave of absence by Gulf to accept this assignment, will have offices at Institute headquarters in New York City.

The Centennial, to be observed throughout 1959, commemorates the one-hundreth anniversary of the oil industry, dating from the drilling of the first commercial oil well in the United States at Titusville, Pa., in August, 1859.

Huber joined Gulf in 1935 as advertising and sales promotion manager. In 1949, he was named general manager of retail marketing, although he continued to direct Gulf's public relations program. Since 1954, he has devoted himself entirely to public relations activities.

Lloyd L. Reynolds has been named assistant plant manager of Ethyl Corp.'s Pittsburgh, Calif., plant and will serve under **James M. Gill,** manager of the plant, who already has established his headquarters near the plant site.

Other appointments to the staff of the Pittsburgh plant are: **Feltus H. Wade,** maintenance superintendent; **James E. Rogers,** operating supervisor; **Earl S. Wirtz,** industrial engineer; **Robert D. Sinner,** engineering superintendent; **Walter G. Weakley,** purchasing agent; **William J. Splaine,** chief accountant; **Orland W. Cooper,** plant chemist; **John Elder,** super-

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Men in the Industry . . .

visor of maintenance; and **G. L. James,** engineer inspector. All of these men have been associated with Ethyl at either its Houston or Baton Rouge plant.

Norman Hardy, executive vice president of the Arbian American Oil Co., has been elected president. He succeeds R. L. Keyes, who is retiring. Hardy has also been made chief administrative officer and a director of the company.

Prior to joining Aramco in 1951, Hardy was president of the Richmond Petroleum Corp., a subsidiary of Standard Oil Co. of California. His headquarters will continue to be in Dhahran, Saudi Arabia.

Dr. Byron M. Vanderbilt has been appointed senior research associate in the Esso Research and Engineering Co. He had been an assistant director in the firm's chemicals research division.

Dr. Vanderbilt, a company veteran of 19 years' service, has 60 U. S. patents to his credit. In his new post, he will be concerned chiefly with work in the reinforced plastics field. Much of his former work with the company has dealt with GR-S synthetic rubber. During World War II, he was a member of the Weidlein Committee, the first government agency concerned with the manufacture of synthetic rubber.

Dr. Vanderbilt is a graduate of Indiana University with an A.B. degree in chemistry. He holds an M.S. degree in chemistry and a Ph.D. degree in organic chemistry, both from Purdue University.

Akiyoshi Tamaki has been appointed president of Chiyoda Chemical Engineering & Construction Co., Ltd. Prior to his recent appointment, Tamaki was director and chief engineer. He replaces Shigoe Okubo who is now chairman of the board.

W. L. Banks has been appointed consulting technologist of the Western Petroleum Refiners Association, Tulsa.

Banks

As consulting technologist for the Association, Banks will have duties which will allow the WPRA to further broaden its service to the refining industry. Banks has had a wide range of experience in the petroleum industry and prior to accepting the WPRA appointment, he was manager of the Tulsa office for the Petroleum Catalyst Division of Davison Chemical Co. Before joining Davison, he served as a division chief in the Central Intelligence Agency in Washington, D. C. His experience also includes nine years as a research and development engineer with The Texas Co., at Port Arthur.

George P. Brandt has been appointed production manager of the new $4 million plant of Callery Chemical Co., at Lawrence, Kan. The appointment of Brandt, a chemical engineer, was announced by **R. G. Schmidt,** manager, Lawrence division.

Brandt

A graduate of Mississippi State College, Brandt holds a B.S. degree in chemical engineering. He also did graduate work in chemical engineering at the University of Texas.

Brandt was a production and control supervisor at the Oak Ridge, Atomic Energy Project from 1944 to 1947. He joined Callery in 1953 as a section head in research and development, and he has been associated with the Lawrence project since its beginning.

Virgil A. Josendal and **Frederick W. Staffgen** have been promoted to senior research chemist and **B. J. Young** has been made senior process engineer at the Union Oil Co. of California Research Center, Brea, Calif.

H. D. Kinsey has been named president of Union Carbide Olefins Co., division of Union Carbide Corp. Other officers are: **R. N. Graham,** executive vice-president; **W. F. Reich, Jr.,** executive vice president; **N. C. Babcock,** vice-president—marketing; **L. J. Bowditch,** vice-president—engineering; **G. T. Felbeck,** vice-president—research; and **E. P. Shetter,** vice-president—production.

Dr. Guy Waddington, director of the National Research Council's Office of Critical Tables, Washington, D. C., has won the Southwest Award of the American Chemical Society for 1957.

The award, which consists of a bronze

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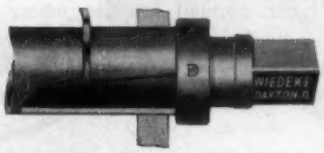

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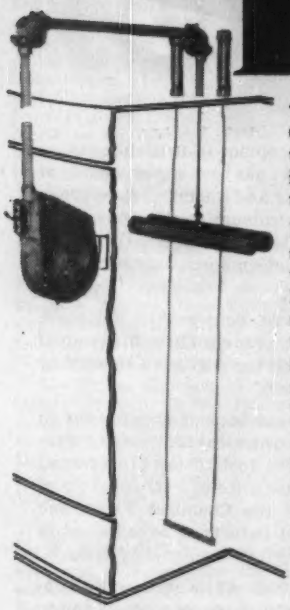

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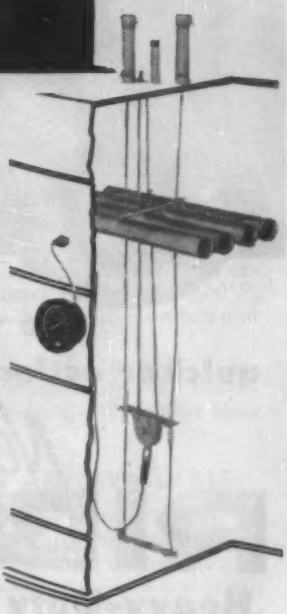

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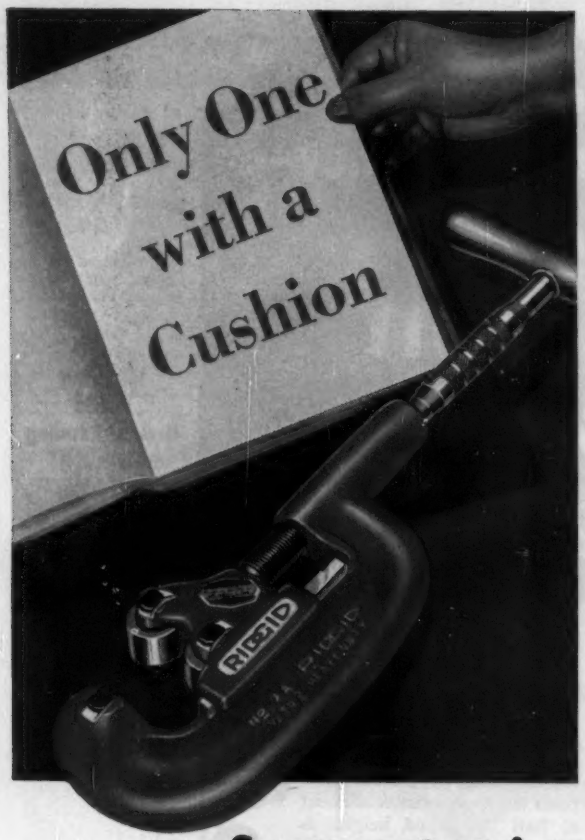

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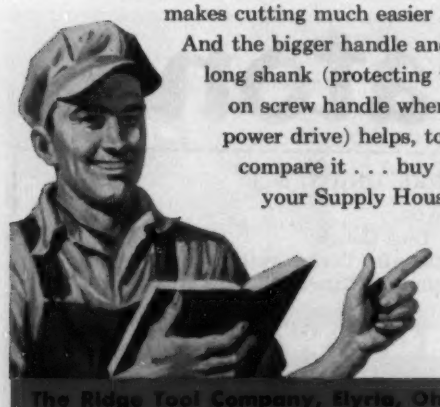

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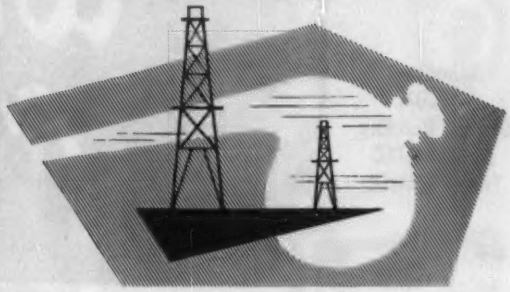

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Men in the Industry . . .

plaque and a cash prize, was presented to Dr. Waddington at a banquet last month.

Dr. Waddington, who was director of a petroleum research project at the U.S. Bureau of Mines Petroleum Experiment Station, Bartlesville, Okla., before joining the National Research Council, is noted for his research in chemical thermodynamics. In 1953, he received the highest honor of the U. S. Department of Interior, its Distinguished Service Award.

Harry D. Dobe has been appointed assistant maintenance superintendent of Great Northern Oil Co., it was announced by **A. S. Gilliam**, vice president and plant manager.

Dobe

Previously associated with Esso Standard Oil Co., at Baltimore since 1950, Dobe served as Esso's head of Maintenance and Construction Planning and Coordination before joining Great Northern. He received an engineering degree from Johns Hopkins University, Baltimore, in 1949.

Charles B. Towill has been appointed public relations representative for the Fifth World Petroleum Congress, Inc., 527 Madison Avenue, New York 22. The six-day Congress, the first of its kind to be held in the United States, will open in New York's Coliseum on May 31, 1959.

Towill was manager of the Public Relations division of the Iranian Oil Participants, Ltd., in London until returning to New York in June this year. Previously he was with The British Petroleum Co., Ltd., and served with that company in Iran and New York.

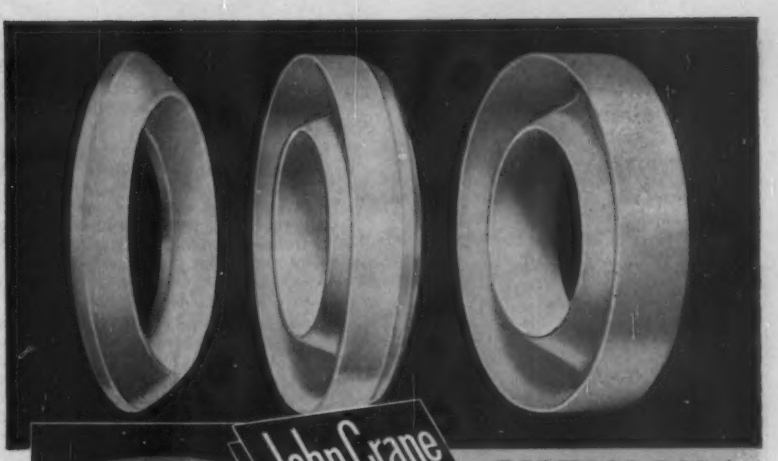
D. B. Benedict has been elected a vice-president of Union Carbide Corp. it was announced by **Morse G. Dial**, president. Benedict has been president of Union Carbide Chemicals Co., division of the corporation. In his new position he will be responsible for chemicals and plastics activities.

Dial also announced the appointment of **E. E. Fogle** as president of Union Carbide Chemicals Co., and of **H. D. Kinsey** as president of the newly formed Union Carbide Olefins Co., also a division of the corporation. The Olefins Co. will handle the production and sale of ethylene, propylene, butadiene, and other hydrocarbon products.

Benedict joined Union Carbide in 1933 as a technical assistant in the South Charleston chemicals plant where he became general superintendent in 1952. In 1953 he was made assistant works manager for the Chemicals Co., works manager in 1954, vice-president in 1955, and president in 1956.

Fogle became associated with Union Carbide in 1930 as a research fellow for the Chemicals Co., at Mellon Institute. In 1947 he was appointed assistant sales manager in New York, and in 1954 became vice-president.

Kinsey joined Union Carbide in 1924



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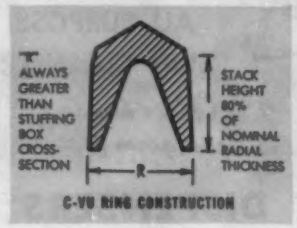

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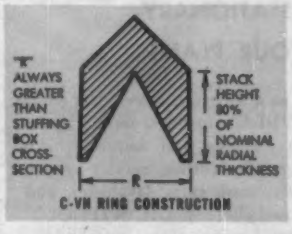

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Men in the Industry . . .

as a cadet engineer for the Chemicals Co., in Clendenin, W. Va. Later he was transferred to the Whiting, Ind., plant as superintendent, and after that moved to Oak Ridge as plant manager for the Manhattan Project. He moved to New York in 1946 as works manager for the Chemicals Co., and was appointed vice-president in 1954.

Ben S. Smith, director of industrial relations for Monsanto Chemical Co's. Lion Oil Company Division at El Dorado, Ark., has been appointed manager of personnel research for the company's Personnel Relations department here.

John Suman, Houston, has been awarded the John Fritz Medal for 1958. Suman is former vice president and director of the Humble Oil & Refining Co. and of the Standard Oil Co. (New Jersey).

The citation to accompany the award states the selection of Suman was made because he has been a "pioneer in the application of engineering principles to the development, production, and conservation of petroleum and natural gas; author; industrial statesman; and one who takes a keen interest and real pleasure in inspiring men to make the most of their talents."

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Ralph D. Webb, head of the instrument department of Union Carbide Chemicals Co.'s South Charleston plant and veteran of 33 years in the instrument field, has been elected to honorary membership in the Instrument Society of America. This award is the highest honor the society can bestow in recognition of an individual's outstanding contributions to the art and science of instrumentation and automatic control.

Clifford Oman has been named assistant plant manager for National Petro-Chemicals Corp., Tuscola, Ill. The announcement was made by **Robert H. Cornwell,** vice president in charge of production for U. S. Industrial Chemicals Co., division of National Distillers and Chemical Corp.

Oman

After receiving his B.S. degree in chemical engineering from the University of Minnesota, he was employed by Elgin Softner Corp., Atlas Powder Co., and Shell Oil Co. In 1951, Oman joined National Petro-Chemicals as area superintendent at the Tuscola plant. Prior to his new appointment, he was process superintendent.

He is a member of the American Institute of Chemical Engineers.

Dr. Joseph J. Wocasek, formerly a group leader in process development at Celanese Corp. of America's Point Pleasant, W. Va., chemical plant, was recently appointed product development engineer for new chemicals in the Product Development department of the company's Chemical division, New York. He joined Celanese in 1954 as a research chemist at the Clarkwood, Texas, chemical research center.

Jennings Allen, who has been in Europe for the past two years, has been named to the post of section head in charge of inspection and expediting activities for the European engineering office of Esso Research and Engineering Co. He is attached to the firm's branch in The Hague, Netherlands.

Allen joined the company in 1946 as a welding inspector. Next he spent 6 months in Canada on field inspection work and followed that by heading welding inspection work at the Fawley refinery project in England from 1949 through 1953.

In 1955 he was assigned to Antwerp, Belgium, and was located there until his recent appointment.

John F. Ryan has been named an acting section head in the chemicals development division of Esso Research and Engineering Co. Dr. Ryan earned his Ph.D. in chemical engineering at Penn State. His B.S. in the same field was granted by the University of Illinois.

He joined Esso Research in 1953. Before that he spent two years with Firestone Plastics in Pottstown, Pa.

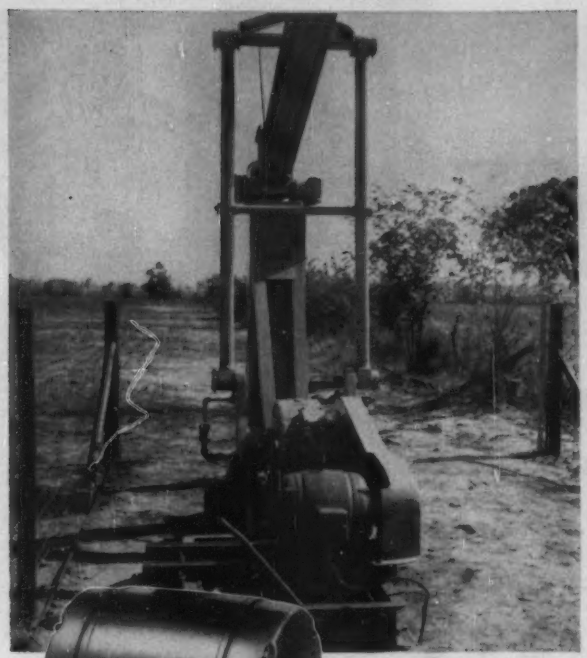
Dr. Neil F. Baumgartner has been named a section head in the chemicals research division of Esso Research and Engineering Co. Dr. Baumgartner has been

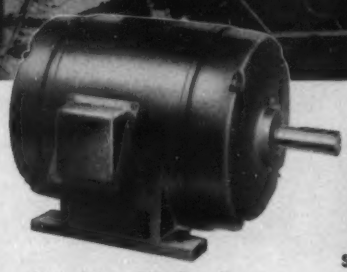
For more data on advertised products, use Readers' Service Cards, last page.

These Wagner Motors are designed to

Cut Operating Costs

in the oil fields



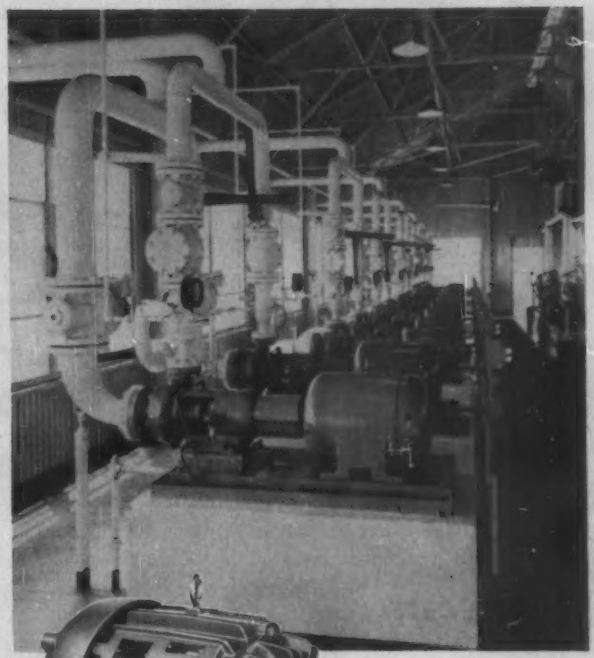


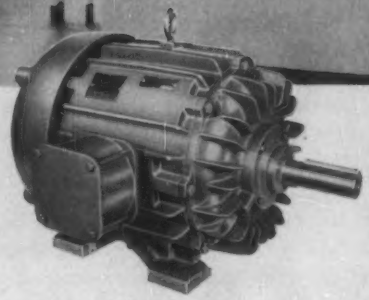
Type DP or DY oil well pumping motor. Single phase or polyphase.

Separate weatherproof control box, for use with single phase motors.

Wagner oil well pumping motors are especially designed for cost-cutting year round, maintenance-free, rugged outdoor service. They are protected against rain, sand, snow, by an enclosure that is completely dripproof—virtually splashproof. They are protected against corrosion by cast iron frames and endplates. Conduit boxes are moistureproof and dust-tight. They are available from stock in your immediate area for either polyphase or single phase operation. Single phase motors are of the high power factor capacitor start and run type with a separate weatherproof control box that contains the starting and running capacitors and voltage relay.

in the refinery





Type JP, Explosion-proof, totally-enclosed polyphase motor. Available in ratings through 250 hp.

You cut costs when you install Wagner Type JP Explosion-proof motors in your refinery because these totally-enclosed motors have extra protection that means longer motor life with little maintenance—the vital parts of the motor are sealed against the entrance of dust, fumes and moisture that are the causes of most motor maintenance problems. These motors are approved for Class 1, Group D hazardous locations, and can be used indoors or in exposed outdoor locations where corrosion is a problem. Totally enclosed fan-cooled motors are available in ratings through 400 hp.

For full information, write for Bulletins MU-132 and MU-137, or phone a nearby Wagner branch.

Wagner Electric Corporation
SERVING INDUSTRY SINCE 1891

WM58-3

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Wagner Electric Corporation
6458 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

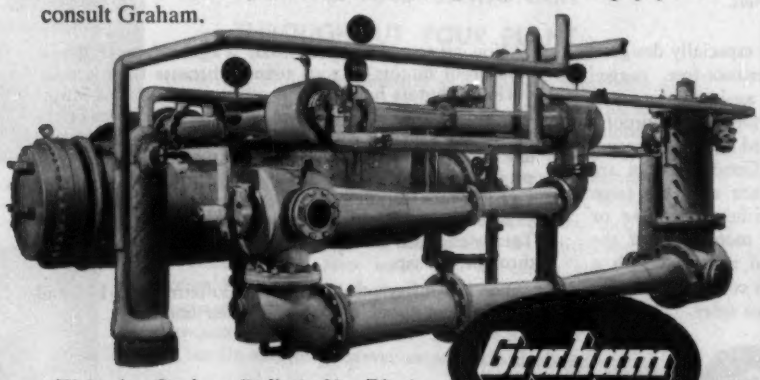
We've come a long way too

vacuum
Graham experience—like this old timer—dates 'way back

Today, through constant research, our "know-how" has reached a "high" where industry realizes that the solution of any vacuum problem is better handled by Graham engineering, and in special cases is augmented by the complete resources we have available for further exploration.

If vacuum is your problem, we offer you the proper type of steam or gas propelled ejector ranging from the smallest and simplest single stage unit up to and including the more complicated 7 stage type shown below, capable of sustaining 1 micron absolute pressure.

Our entire line of steam jet ejectors involves a completely new series of designs that have not only produced improved efficiencies but prices and deliveries that are more competitive than heretofore. Don't miss a bet. If you have a vacuum problem it will pay you to consult Graham.



Write for Graham Bulletin No. 70-A.

GRAHAM MANUFACTURING CO., INC.
415 LEXINGTON AVENUE, NEW YORK 17, N. Y.
Offices in principal cities and Canada

Men in the Industry . . .

with Esso Research since 1948. He joined the company soon after he was awarded his Ph.D. degree in chemistry at the University of Illinois. He earned an A.B. degree in Miami University, Oxford, Ohio.

Bennett

Hoffman

R. B. Bennett and **E. J. Hoffmann** have been promoted to research specialists in Research and Development division at Humble Oil & Refining Co.'s Baytown, Texas, refinery. Bennett is specializing in the development of new types of special lubricants and process oils. At present serving in Humble's executive development program as head of the section engaged in research on fuels processes, Hoffmann plans to specialize in the planning and evaluation of long range research on the production of fuels and petrochemicals.

Bennett and Hoffmann hold B.S. degrees in chemical engineering from The University of Texas.

Herman Boucher has been named refinery superintendent of the Vickers Petroleum Co.'s Potwin, Kan., refinery. He will fill the post vacated by **Quentin Benedict** who resigned to accept another top position with another company.

With principal responsibilities in the economics and supervison of general refinery operation and processing, Boucher will operationally complement the duties of **Fred McFarlaine,** chief refinery engineer for Vickers.

Boucher received his B.S. degree in chemical engineering from the University of Missouri and has had a wide and varied background in refinery operation.

Paul G. Bissiri, materials and standards engineer at the Los Angeles refinery of the Union Oil Co., has been assigned to the company's Santa Maria refinery as supervisor of technical services, succeeding **David Davidson** who has been assigned to the Los Angeles refinery as a staff engineer in the Distillation and Alkylation department.

Bissiri holds a B.S. degree from Stanford University and an M.S. degree from the California Institute of Technology, both in mechanical engineering. Davidson is a graduate of Stanford University with B.S. and M.S. degrees in mechanical engineering.

James J. Graham, Willem Versluys, and **Richard E. T. Brooks,** have all joined Badger Manufacturing Co. as process engineers. **Arthur Joseph Kessler** has joined the company as a project engineer.

Graham received his B.S. and M.S. degrees in chemical engineering from The

For more data on advertised products, use Readers' Service Cards, last page.

End Liquid Metering Problems with a Lapp PULSAFEEDER CONTROLLED-VOLUME CHEMICAL PUMP

NO LEAKAGE
NO PRIME LOSS
NO CONTAMINATION
NO STUFFING BOX

WRITE FOR BULLETIN 440
with typical applications, flow charts, description and specification of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Division, 540 Poplar Street, Le Roy, N. Y.

● Precise metering, pumping, proportioning and feeding of hard-to-handle chemicals is the specialty of the Lapp PULSAFEEDER. Designed for accurate handling of corrosive and non-corrosive liquids, it is a combination piston-diaphragm pump . . . providing positive displacement with *no stuffing box*. Leakage or contamination of the liquid being pumped is prevented by a hydraulically balanced diaphragm isolating the liquid from the pump's drive mechanism. All pump parts contacting liquid are of special corrosion-resistant materials. Pumping speed is constant; variable flow results from variation in piston-stroke length, controlled manually by hand-wheel, or, in auto-pneumatic models, by instrument air pressure responding to any instrument-measurable processing variable.

Lapp

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retubed by CONSECO

FOR PHILADELPHIA GAS & ELECTRIC

CONSECO is equipped and thoroughly qualified by over 30 years' experience to repair, re-tube or rebuild any type of tubular equipment, our own or of any other manufacture. Extensive facilities and personnel handle emergency assignments on the job or in our own shops. A CONSECO re-built unit is usually a better product than the original equipment because it benefits, during repairs, from our familiarity with all types of tubular equipment and of features that help to achieve longer, trouble-free, more efficient operation.

Full maintenance and spare parts service available. Emergency service at any hour, day, night, holiday; anywhere on the continent. Just call Maintenance Department.

● **Conseco Service is as near as your telephone**

When equipment is repaired or rebuilt thoughtfully, as CONSECO does, changes in design, care of construction and ease of maintenance are developed that improve the original product. The application of these improvements to NEW EQUIPMENT DESIGNED BY CONSECO brings genuine profits to users of CONSECO products.

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Designers and Builders of Equipment for Power, Refining, Chemical and Marine Industries

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For more data consult Chemical Engineering Catalog pages 559-562

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HEAT EXCHANGERS • CONDENSERS • EVAPORATORS • STEAM JET AIR EJECTORS • PRESSURE VESSELS • FEED WATER HEATERS • SEWAGE EJECTORS • CONDENSATE COOLERS • ENGINE PARTS • SERVICE WATER COOLERS • FILTERS and STRAINERS • INSTRUMENTS • SPECIALTY ITEMS

COMPLETE BULLETINS SENT ON REQUEST

Men in the Industry . . .

Cooper Union, New York. Versluys received his M.S. degree in 1953 from Technical University of Delft, The Hague; Brooks graduated from Northeastern University in 1957 with a B.S. degree in chemical engineering; and Kessler received his B.S. degree in chemical engineering from Northeastern University in 1949.

E. Clyde Seymour has been named senior vice president of Magnolia Petroleum Co. The appointment culminates a long career with Magnolia which began in 1912 when Seymour was employed as a messenger boy at Magnolia's general offices in Corsicana, Texas. He is the only active member of the organization who saw service with the company headquarters before it was moved to Dallas in 1914.

Morrisson

Hotchkiss

C. C. Morrisson, superintendent of the Receiving and Shipping division at Gulf Oil Corp's Port Arthur refinery, has been promoted to manager of services for Gulf's Philadelphia refinery to succeed H. W. Magee who is being transferred to London, England.

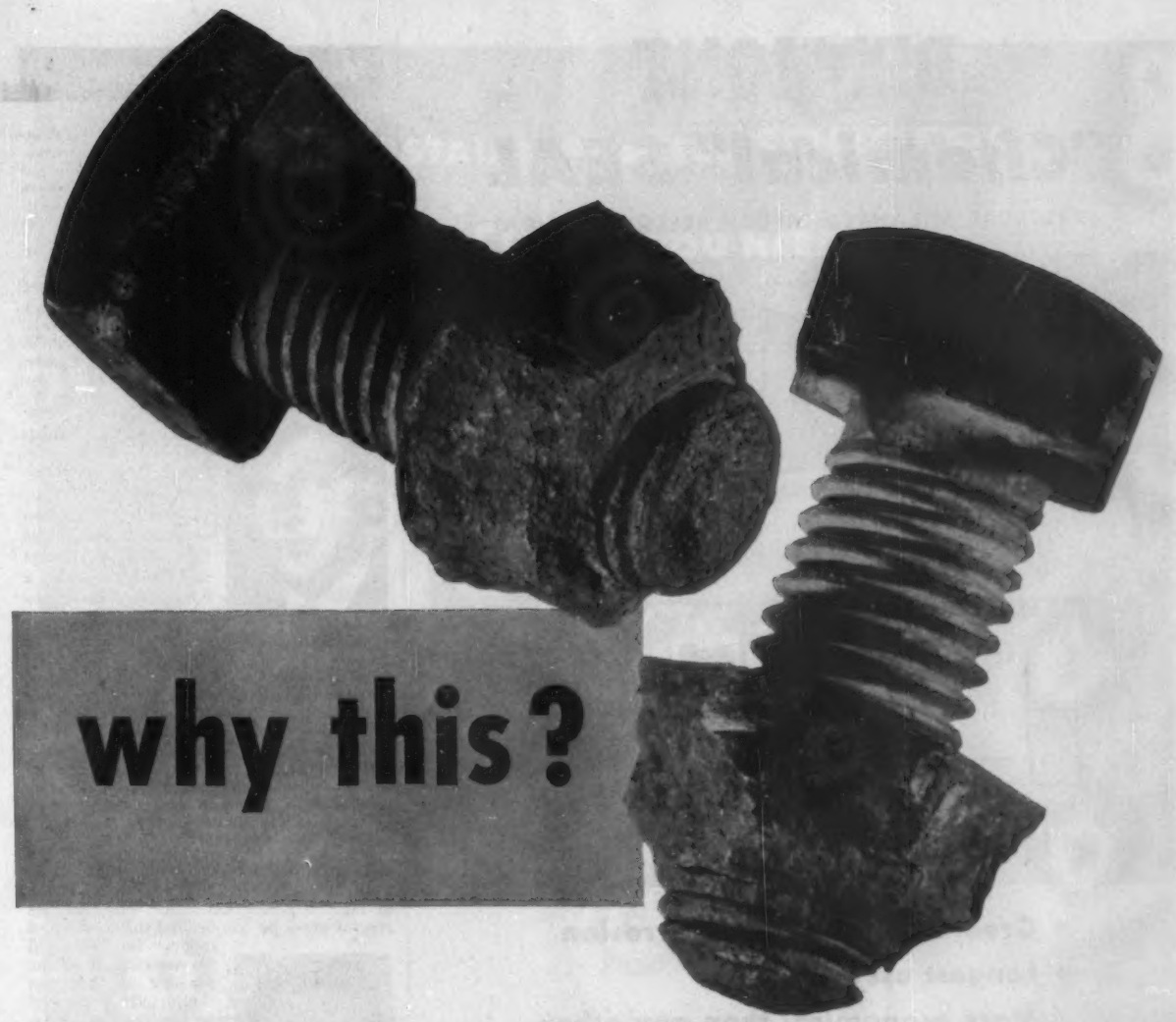
Oscar T. Hotchkiss, Jr., assistant superintendent of the Lubricating department at the Port Arthur refinery, will succeed Morrisson.

Morrisson graduated from Texas University in 1923 with a B.S. degree in chemical engineering. He joined Gulf at the Port Arthur refinery where he remained until 1930 when he was transferred to the Refinery Technology division in Philadelphia. In 1940 he returned to Port Arthur and was promoted to his present position in 1956.

Hotchkiss graduated in 1924 from Texas A. & M. College with a B.S. degree in chemical engineering, and joined Gulf at the Port Arthur refinery that year. He has served as superintendent of the Paraffin department and assistant superintendent of the Lubricating department prior to this promotion.

Benjamin H. Weil of the Esso Research and Engineering Co., Linden, N. J., has been elected 1958 chairman of the American Chemical Society's division of Chemical Literature. Weil who is chief editor of his company's technical information division, succeeds **Dr. John H. Fletcher** of the American Cyanamid Co., Stamford, Conn.

Miss Hanna Friedenstein, Godfrey L. Cabot, Inc., Boston, was chosen chairman-elect and **Miss Virginia R. Valeri,** Arthur D. Little, Inc., Cambridge, Mass., was renamed treasurer. **Dr. Harriet A. Geer** of



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when new aluminum coating holds up so well

On galvanized structures, the rusting caused by atmospheric corrosion usually begins with the bolts and nuts. In time, this presents a serious maintenance problem. But now, at slight extra cost, you can obtain coated fasteners which are so rust-resistant that they outlast any other part of a galvanized structure. These fasteners are coated with Bethalume, Bethlehem's new aluminum coating.

The Bethalume hot-dip coating makes possible a much longer service life for fasteners by adding the corrosion resistance of aluminum to the strength of steel.

Bethalume coatings stand up especially well under "heat-corrosion," at lower cost than products customarily used. Moreover, the Bethalume coating is unusually uniform—not merely on the body of each bolt, but over the entire threaded portion as well, thus making possible threads which are clean and smooth-fitting.

We have a new illustrated booklet on the Bethalume coating, which describes its advantages in detail. If you would like to have a copy, just drop a line to the Bethlehem office nearest you.

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BETHLEHEM STEEL

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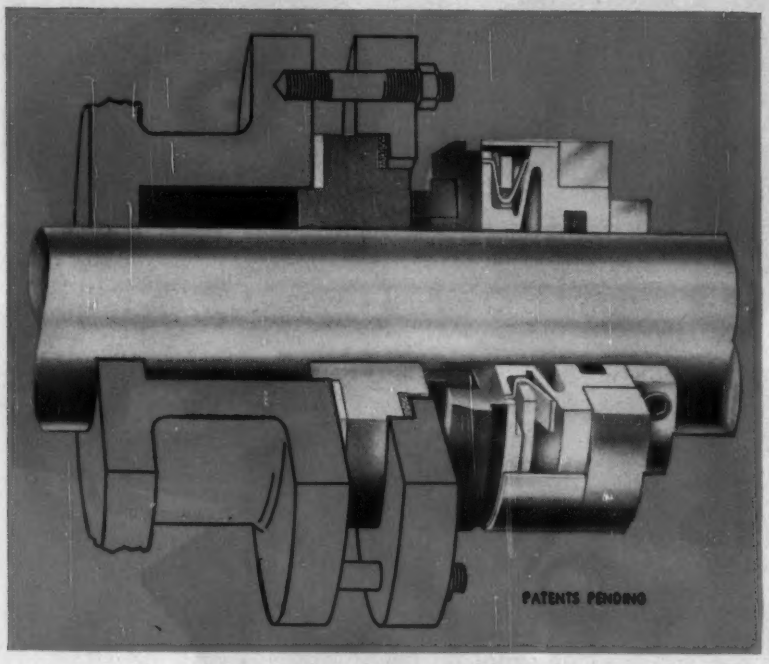
BELMONT

"Chemical" SEAL

(PRESSURE BALANCED TEFLON BELLOWS DESIGN)



- **Greatest immunity to corrosion**
- **Longest useful life**
- **More economical than any other design or materials combination**

Customers report unsurpassed performance in difficult corrosive service with the BELMONT Chemical SEAL. A rotating mechanical seal, it employs a pressure balanced TEFLON* bellows design, free from the weaknesses (corrosion and flexural fatigue) of conventional metallic bellows.

Rotating with the shaft, only bearing surface is between rotating and stationary seal faces. No scoring of shafts. Will work satisfactorily on shafts previously scored by other seals or conventional packing.

Provides a perfect fluid seal without high friction load on the shaft and attendant high power costs. Greatly reduces hazards of handling flammable, explosive, corrosive and toxic liquids, and will handle abrasive slurries (when proper flushing means are provided). For pressures at the seal up to 100 psi at 75° C. Temperatures to 100° C at 75 psi. Standard sizes to fit shafts from ⅞" to 2¼".

Ask Your Belmont Distributor or write for Catalog T-57.

The Belmont Packing and Rubber Company
Butler & Sepviva Streets, Phila. 37, Pa.

* du Pont Trademark

BELMONT

Men in the Industry...

the National Research Council, Washington, D. C., is the new division secretary.

Weil, who has carried out important research on the economics of petroleum refining processes and products, has written numerous technical articles and is the author of several books.

Byron J. Anderson has been named manager of the polyethylene plant which will be built at Houston by National Petro-Chemicals Corp. The announcement was made by **Robert H. Cornwell**, vice president in charge of production for U. S. Industrial Chemicals Co., division of National Distillers Products Corp.

Anderson

In 1943 Anderson graduated from the University of Alberta in Canada with a B.S. degree in chemical engineering. He was employed from 1943 until 1952 by Imperial Oil Co., Ltd., at the Calgary, Alberta and Montreal, Quebec refineries and was a senior technologist before he joined National Petro-Chemicals in 1952. Anderson started as ethylene area superintendent and was serving as assistant chief technologist at National Petro-Chemicals', Tuscola, Ill., Plant at the time of his appointment as plant manager at Houston.

J. P. Hamilton has been promoted to head of the Cost and Evaluation division in Humble's Houston office. For the past several years he has headed the Economics section in Technical Service division at the refinery and has just completed a special assignment in New York with an affiliated company.

Hamilton

Hamilton has been a member of Technical Service division since graduating at Rice Institute in 1939. Initially, he worked in catalytic cracking. At the end of World War II he became interested in engineering economics, comparing alternate processing techniques and manufacturing processes to determine the most efficient methods of conducting current and long range operations.

William R. Remalia has been appointed general supply manager for the American Oil Co. He succeeds **I. W. Fariss**, who has resigned.

Succeeding Remalia as manager of products supply will be **Edward G. Spottswood**, who moves up from the position of assistant manager of products supply.

Remalia joined Standard Oil Co. (Indiana) in 1938 as a chemical engineer at the Whiting, Indiana, refinery. In 1945, he moved to Standard Oil's home office in Chicago and five years later was transferred to Pan-Am Southern Corp., an affiliated company, in New Orleans as manager of economics.

He joined the New York office of

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WHY BUY STAINLESS STEEL squares WHEN IT'S circles YOU NEED?

This circle, 9/16" thick x 164" diameter, is one piece of Type 316L stainless steel. Had the customer ordered a square, he would have paid freight on a half-ton of excess material. Also, he would have had the problem and expense of handling the square and cutting the circle.

Here are four sound reasons why Carlson customers save time and money when they order the circles they want—rather than the squares they have to cut . . .

1. If the gauge and size are circle-shearable, there is no extra charge for cutting the circle. This saves cutting labor and scrap handling expense.
2. If the gauge is such that a cutting charge applies to the square, it pays to order the circle. This eliminates the extra charge for cutting the original square and involves only the one charge for cutting the circle.
3. Because circles weigh approximately 25% less than squares, there's a substantial saving in transportation costs.
4. Small or medium size circles are often available from stock when squares may not be. The delivery time saved can be an important factor.

When you need stainless steel circles, come to Carlson where we specialize in stainless steel . . . that's your guarantee of dependable service.

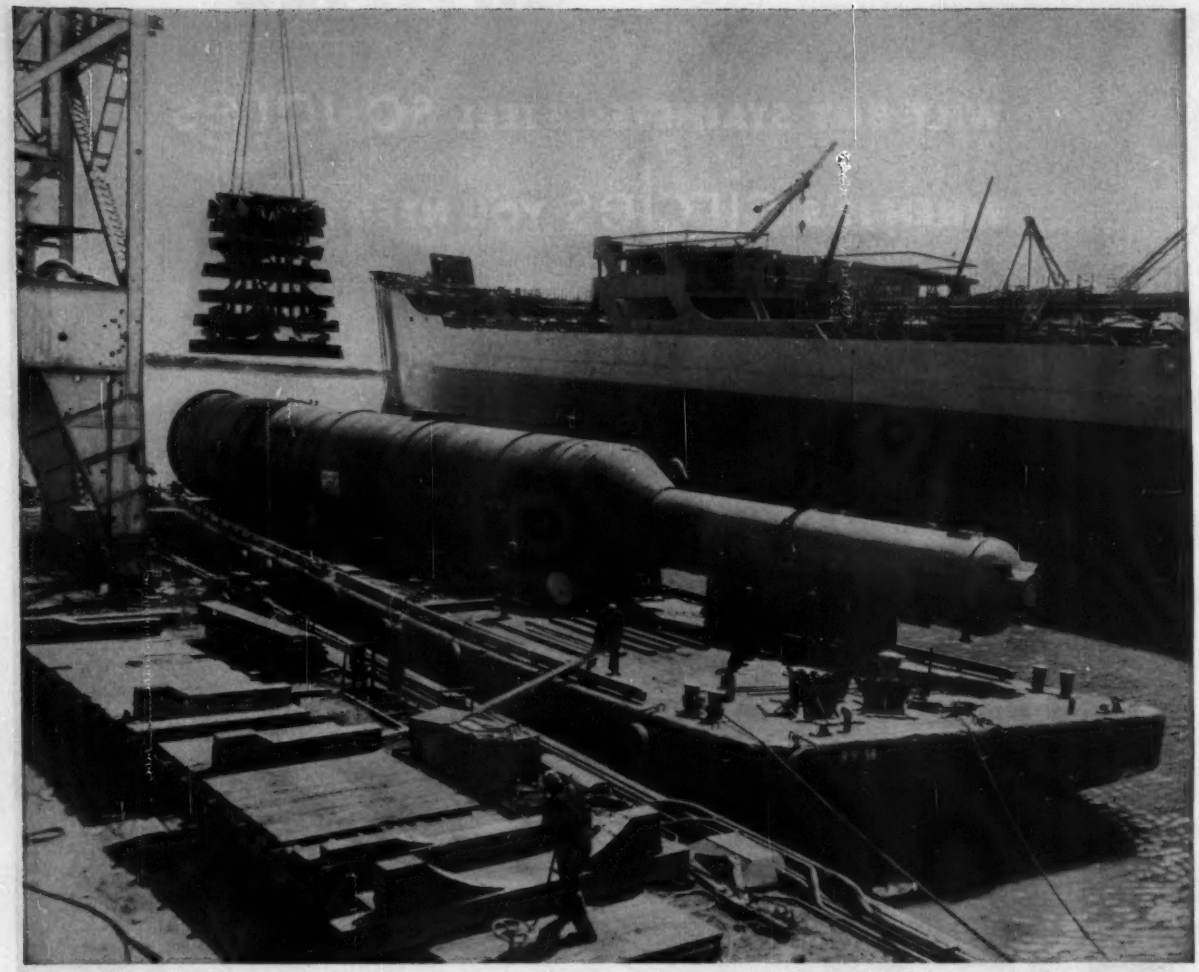
Stainless Steels Exclusively

G. O. CARLSON Inc.

THORNDALE, PENNSYLVANIA

District Sales Offices in Principal Cities

Plates • Plate Products • Forgings • Bars • Sheets (No. 1 Finish)



standard procedure: VERSATILITY...

The variety of work which Sun Ship's integrated shops produce for use by industries on land and sea brings a matching variety of shipping problems.

Our facilities for tidewater shipment are used to economical advantage on many of the massive structures that go into the making of the nation's petroleum and chemical industries. The barge shipment of tower and shed row baffles, shown above, is a good example.

And of course—when shipment by land is necessary—Sun Ship rigging and routing find the ways and means to handle such items as large-diameter columns by rail and truck.

It's all a part of the versatility which forty years' experience has made part of "standard procedure" in service of its customers.

Our Sales Engineering Department would be glad to use its experience in helping you overcome any problem of construction or shipment that faces you. Write

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE SINCE 1916 **CHESTER, PA.**

Men in the Industry . . .

American Oil in July, 1956. A native of Warren, Ohio, Remalia graduated from Carnegie Institute of Technology in 1938 with a B.S. degree in chemical engineering.

Spottswood joined American Oil as a chemical engineer in June, 1943, shortly after his graduation with a chemical engineering degree from the University of Oklahoma. He was transferred to the New York office in April, 1948.

Bruce D. Carroll has been named to the newly-created post of manager of operations of Canfield Oil Co. Carroll, a 1950 graduate of Ohio State University with a B.S. degree in biological chemistry, has been in The Standard Oil Co. (Ohio) manufacturing department since 1950. Starting as a sampleman at the Sohio Lima Refinery's laboratory, he was promoted to tester, then to lab technician. For the past year he has been an engineer on the manufacturing's operations staff.

Carroll

Greaney

Wilson

T. J. Greaney and G. W. Wilson have been promoted to assistant division heads in Technical Service Division at Humble Oil & Refining Co.'s Baytown, Texas, refinery. Greaney is responsible for the activities of the economic analysis, the catalytic cracking, the catalytic light ends, and the aviation sections of the Division. In addition the specialists on electronic computers come under his supervision. Wilson is responsible for the activities of the lubricating oil, distillate finishing, and distillation and utilities sections; the Technical Service Practice School is also under his supervision.

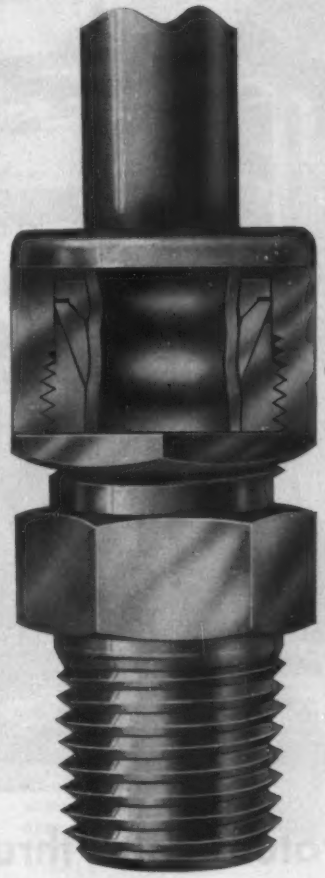
Both Greaney and Wilson are graduates of Rice Institute with B.S. degrees in chemical engineering.

Esso Research and Engineering Co. has appointed twenty-six chemists and engineers research or engineering associates since the firm announced its "ladder of technical staff progression" five months ago.

The ladder offers an expanded course of promotion, prestige and recognition to professional employees whose primary interests and talents are along technical lines. Thus professional men can progress in their own technical fields as well as on the administrative side of the business.

Of the first 26 men named to the new

torque-free leakproof seal



★ easily installed ★ engineered to meet the most exacting specifications ★ available in any machinable metal or plastic ★

Swagelok®

TUBE FITTINGS

For information on the extensive line of Swagelok Tube Fittings that provide a true torque-free leakproof seal and the name of your Swagelok Specialist, write Dept. D1.

CRAWFORD FITTING COMPANY
884 East 140th Street • Cleveland 10, Ohio

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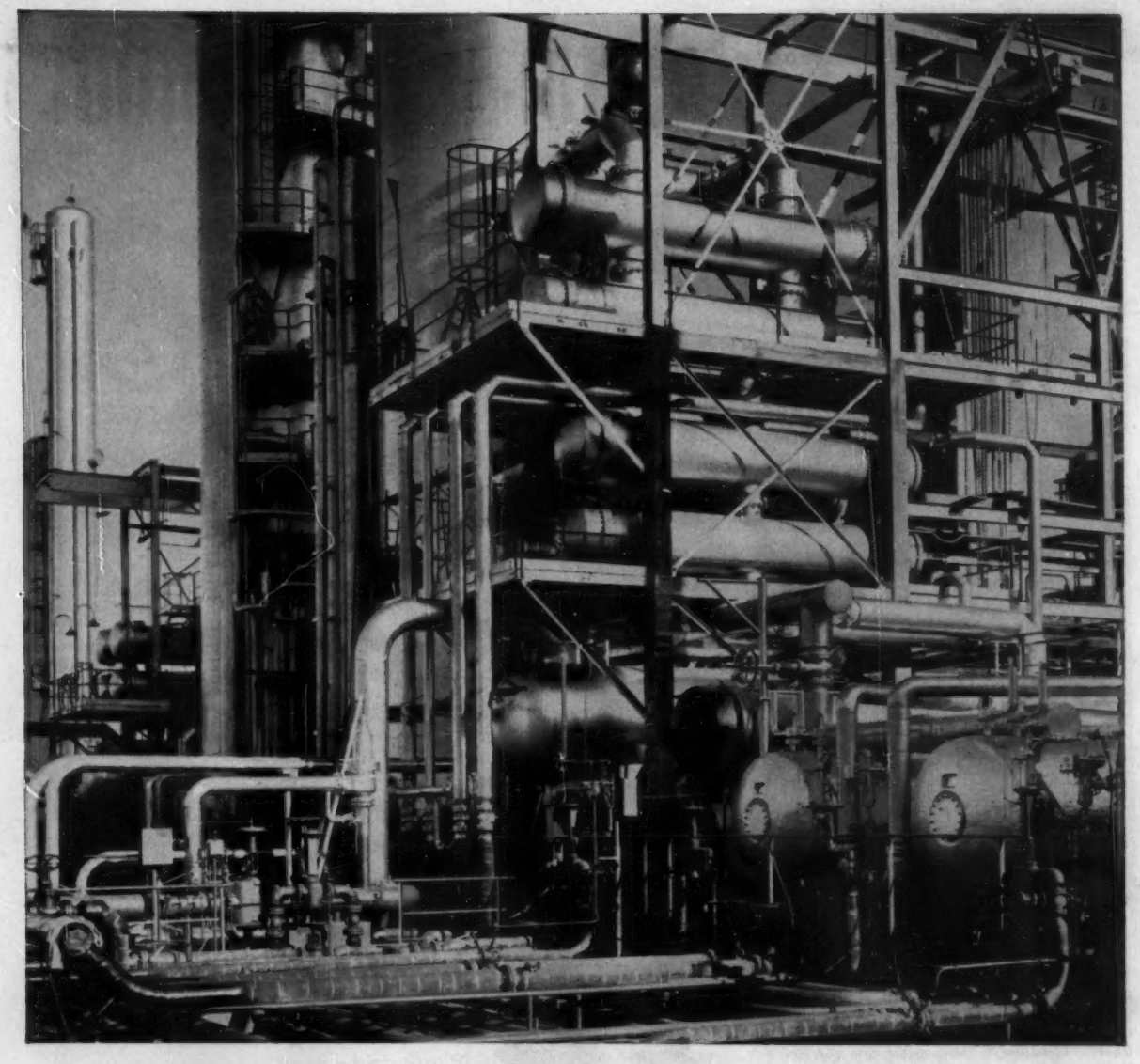

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Carpenter Stainless Tubing holds corrosion costs **DOWN**

• Is the threat of rapid deterioration of tubing in heat exchangers and other process units keeping you from raising temperatures and increasing velocities?

Carpenter Stainless Tubing and Pipe have proven their ability to stand up under increased temperatures and thruput, with substantial cost reductions in material, labor and downtime.

Complete line of 14 standard AISI analyses and many other special alloy grades are available. Write for latest Selecting and Buying Guide . . . or contact your Carpenter Distributor now.

MEMBER

The Carpenter Steel Company
Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"

Carpenter

Stainless Tubing & Pipe

For more data on advertised products, use Readers' Service Cards, last page.

Men in the Industry . . .

titles, 15 are chemical engineers, nine are chemists, one is a physicist and one a mechanical engineer. Their average company service is 16 years.

Engineering associates are Ivan Mayer, Lewis D. Etherington, Brook I. Smith, Walter J. Paltz, Bruce R. Tegge, William E. Catterall, Stephen F. Perry, E. Wendell Carrier and Allen R. Crawford.

Research associates are Mervin E. Conn, John J. Heigl, Anthony H. Gleason, Charles W. Skarstrom, James F. Black, Eric O. Forster, Joseph C. Roediger, Arnold J. Morway, Robert B. Long, Isidor Kirshenbaum, Walter G. May, Walter A. Herbst, Meyer A. Efroymson, Eugene S. Corner, Boyd E. Hudson Jr., Nathaniel H. Rickles and Leland K. Beach.

Dr. James C. Kirk has been appointed director of research for Petroleum Chemicals, Inc. Dr. Kirk, who was formerly research supervisor for the Petrochemicals Research division of Continental Oil Co., will be located at Lake Charles, La.

Dr. Kirk secured his Ph.D. degree from Ohio State University in 1949 and his B.S. degree from Baylor University in 1944. He has been associated with the Petrochemicals Research division of Continental since receiving his degree from Ohio State.

John T. McDonnell and **James K. Sorgini** have joned the Chemical Marketing group of the Petrochemicals department, Gulf Oil Corp.

McDonnell is located at Houston, Texas, where he represents Gulf's petrochemical marketing interests in the Gulf Coast area.

Richard T. Peterson, **Robert R. Riggs,** and **Ralph J. Weling** have joined Ethyl Corp.'s Refinery Technology division at its Detroit Research Laboratories.

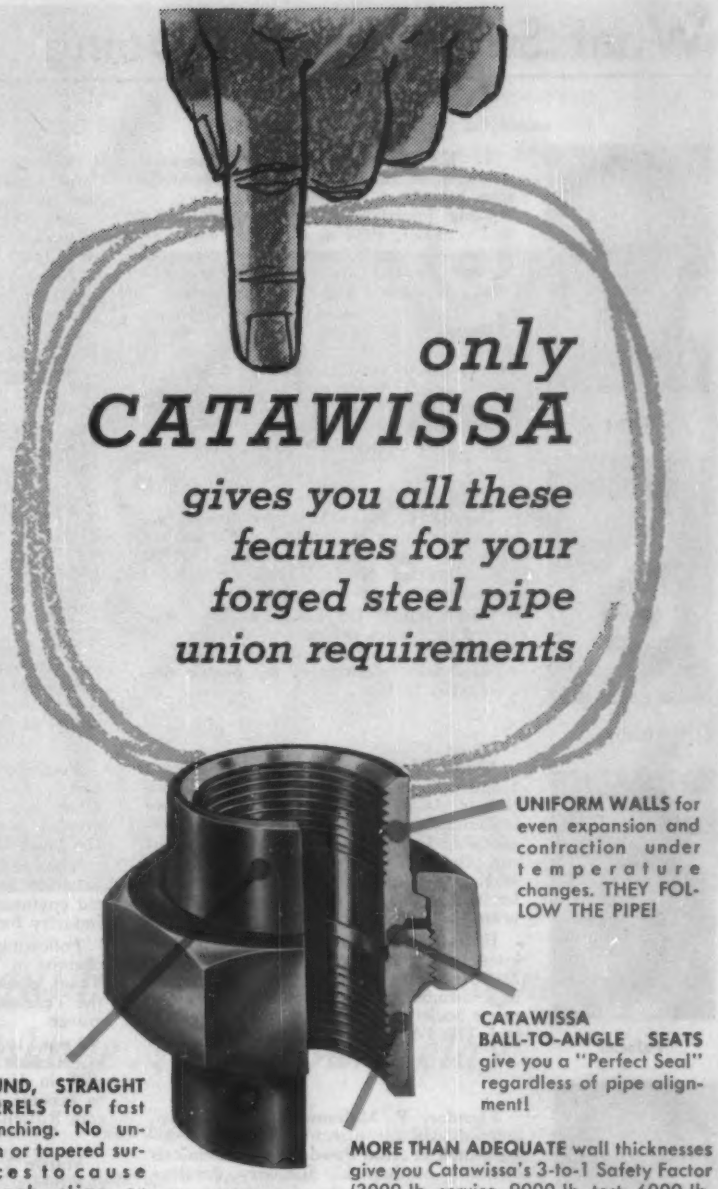
Peterson holds a B.S. degree in chemistry from the University of St. Louis. Riggs holds a B.S. degree in chemistry and an M.S. degree in refinery engineering from the University of Tulsa. Weling holds a B.S. degree in chemical engineering from the University of Detroit.

C. R. Vegh Garzon, engineer, has resigned the position which he has held for several years with Universal Oil Products Co., Des Plaines, Ill., as an advisor for South American matters.

From its office in Montevideo, Uruguay, the firm to which Vegh Garzon is a member, Vegh and Vegh, Engineers, shall go on attending to technical and commercial matters falling within the scope of its specialized field as well as representing Industrial and Engineering firms from Europe, the United States and South America.

— DEATHS —

Raymond Shaw, 63, founder and president of The Chek-Chart Corp., died last month in Chicago. Born in Salamanca, New York, Shaw spent 18 years in the publishing and advertising business before he formed The Chek-Chart Corp., in 1930. Shaw developed the early Chek-Chart Lubrication Charts that first gave service stations manufacturer-approved lubrication diagrams and instructions.

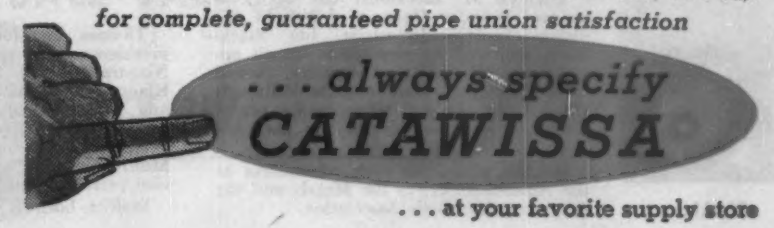

only
CATAWISSA
gives you all these features for your forged steel pipe union requirements
UNIFORM WALLS for even expansion and contraction under temperature changes. THEY FOLLOW THE PIPE!
CATAWISSA BALL-TO-ANGLE SEATS give you a "Perfect Seal" regardless of pipe alignment!
ROUND, STRAIGHT BARRELS for fast wrenching. No uneven or tapered surfaces to cause wrench slips or wrench locking!
MORE THAN ADEQUATE wall thicknesses give you Catawissa's 3-to-1 Safety Factor (3000-lb. service, 9000-lb. test; 6000-lb. service, 18000-lb. test)!

Catawissa Perfect Seal Pipe Unions are made by Union Specialists from 80,000-lb. tensile strength steel (ASTM Spec. A-105-55T, Grade II). Steel forgings from our own forging mill are closely checked for imperfections . . . and finishing on modern, automatic machines with close inspection during and after production give you pipe unions second to none!

Get your free copy of Catalog 56 showing the complete Catawissa line . . . write direct or stop at your favorite supply store.

CATAWISSA VALVE & FITTINGS COMPANY • CATAWISSA, PENNA.,

for complete, guaranteed pipe union satisfaction



. . . at your favorite supply store

For more data on advertised products, use Readers' Service Cards, last page.

What Suppliers Are Doing . . .

Long

L. E. Long was recently appointed manager of the San Francisco electrical sales branch of Wagner Electric Corp.

Long joined the Wagner organization in December, 1934 as a student engineer. From 1936 until assuming the duties of his new position, he was a sales engineer in the company's Los Angeles branch.

A graduate of Missouri University with a degree in Electrical Engineering, he is a member of the American Society of Heating and Air Conditioning Engineers, the National Association of Practical Engineers, the Electrical Maintenance Engineers Association of Southern California and the Electrical Club of Los Angeles.

Bixby

Donald T. Bixby has been named assistant manager of the Standard Products Division of the De Laval Steam Turbine Co., Trenton, N. J. He has been sales manager of the division since 1955.

Bixby joined De Laval in 1945 and served as a sales engineer in the Trenton and San Francisco offices. He was appointed sales manager of the Seattle district office in 1953.

Valaska

Victor Valaska has been appointed foundry superintendent for W-K-M, division of ACF Industries, Inc., effective immediately. Valaska, who will be responsible for all production operations at the foundry, was transferred from W-K-M's iron foundry in Detroit where he held a like position for the past four years.

He attended Cornell University and later took additional work in Industrial Engineering at North Carolina State. He is a member of the American Foundrymen's Society, Grey Iron Foundry Society, and The Foundrymen's Association.

Malinowski

Theodore P. Malinowski has been appointed assistant director of product development in Atlas Powder Co.'s Chemicals division. Malinowski, formerly development manager in the department, will head the exploratory field development and marketing research sections of the department in the newly-created position.

He joined Atlas in February, 1956, after 10 years' service as a development engineer in the product development department of Monsanto Chemical Co.'s Plastics division. He received a B.S. degree in chemistry from Brown University in 1942.

Blackburn

Glenlyn H. Blackburn has been appointed Foundry Manager of W-K-M, Division of ACF Industries, Inc. Blackburn, who will be responsible for all operations at the new foundry, joined W-K-M after 22 years with the Walworth Co., Greensburg, Pa., where he was superintendent of foundries for the past five years.

He has served on such committees as the American Society for Metals and the American Standards Association.

Warren E. Moore, formerly production engineer with Haynesville Operators Committee, has joined Tretolite Co. as corrosion engineer. He is located at Bossier City, La. and will cover the East Texas and North Louisiana area.

He succeeds **James W. Hakeman,** formerly senior corrosion engineer for Tretolite at Shreveport, La. Hakeman recently was named assistant to the Rocky Mountain division manager, **L. C. Dessert, Jr.,** and has located at Edmonton, Alta., Canada.

Moore has been with the Haynesville Operators Committee since receiving his M.S. degree from Louisiana Polytechnic Institute in 1951.

Moore

Albert W. Brandmaier has been named manager of the European regional sales office of Consolidated Electrodynamics Corp. The office, located in Zurich, Switzerland, the past two years, has been moved to Frankfurt, Germany, around Jan. 1.

In his new post, Brandmaier will coordinate the sales effort of Consolidated's authorized sales representatives throughout Europe, including the United Kingdom and the Scandinavian countries.

Brandmaier

Fred Royse, sales manager of the Fluor Corp., Ltd., Houston sales office since 1946, has been promoted to the newly created post of vice president, sales, for the Fluor Corp. of Canada, Ltd.

The executive, who graduated from Rice Institute in 1930 with a B.S. in chemical engineering, has been active in the oil industry for the past 27 years.

Following graduation he worked as a chemist in The Texas Co.'s Port Arthur, Texas, research lab. In 1932 he went with the Tenmant Co., Houston, as a sales engineer.

From 1935 to 1941 he was a member of Humble Oil Co.'s technical services staff in Houston. He left there in 1941 to become a sales engineer for the Griscom Russell Co.

Royse

Martin V. Kiebert, formerly director of electronics for the Miami Shipbuilding Corp., has joined Datalab, a division of Consolidated Electrodynamics Corp., as proposals coordinator.

A former Navy commander, Kiebert was head of the special weapons branch of the government's Bureau of Aeronautics during World War II. In this capacity, he was responsible for all of the bureau's electronic activities in guided missiles.

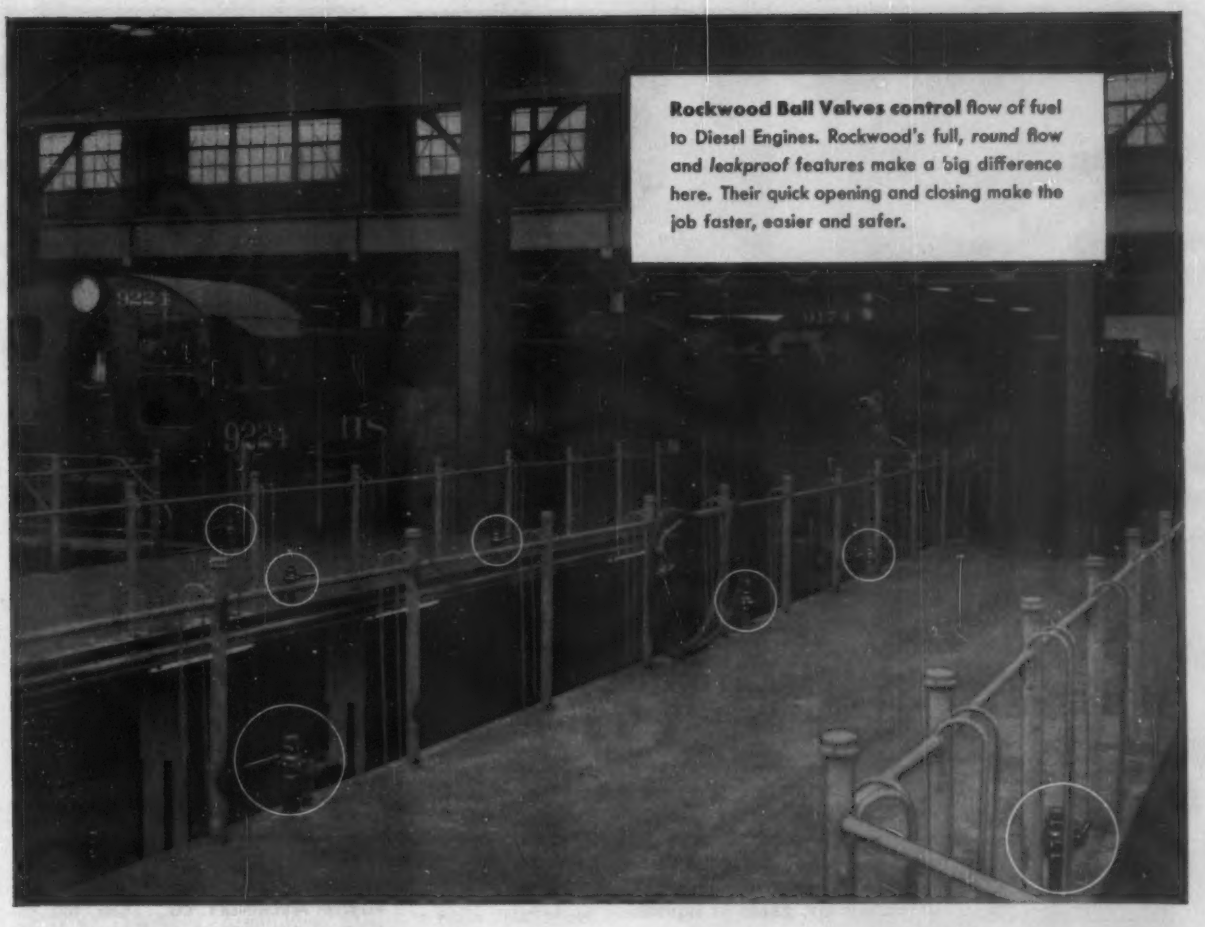
A graduate of the University of Idaho with a B.S. degree in electrical engineering, Kiebert is a registered professional engineer in the District of Columbia.

Kiebert

Thomas E. Moffitt has been elected president of Hooker Electrochemical Co., Niagara Falls, N. Y. He succeeds **Bjarne Klaussen** who will continue as a director and who had served for nearly a year beyond the company's normal retirement age of 65 by special request of the board. Moffitt had been a director and executive vice president since January 1956.

Moffitt, born in Wallace, Idaho, gradu-

Moffitt


Rockwood Ball Valves control flow of fuel to Diesel Engines. Rockwood's full, *round* flow and *leakproof* features make a big difference here. Their quick opening and closing make the job faster, easier and safer.

Flammable liquids handled with safety ... without leakage ... without delay

Rockwood Ball Valves are ideal for handling flammable fuel oils. They handle quickly, easily! The reasons are —

Rockwood Ball Valves with *Full Round Flow* eliminate turbulence and provide minimum friction loss.

Only a quarter turn is needed to open or close the valve.

Rockwood Ball Valves have a chrome-plated ball that holds up under tough abrasion, pitting and scratching — that means *Long Wear-Resistance.*

Rockwood exclusive corrugated spring design and the pressure of the fluid *automatically* position the ball against the seat for a completely *Leakproof Seal.*

These features pay off on handling fuel oils. Rockwood Ball Valves deliver flammable fluids at the volume you want quickly, without leakage and a minimum of maintenance. The only other thing you could ask for is more information — and the coupon below will get it for you.

Tested and listed by Underwriters' Laboratories, Inc. Distributors in principal industrial areas.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
2230 Harlow Street
Worcester 5, Mass.

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

Name.....
Title.....
Company.....
City.....
Zone.....*State*.....

For more data on advertised products, use Readers' Service Cards, last page.

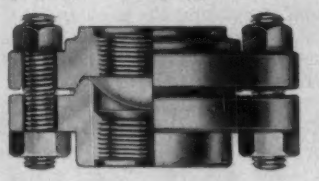
Tranquilizer... made of metal

You don't swallow this "tranquilizer"... but it can bring you priceless peace of mind! It's the rupture disc in a BS&B Safety Head—one of thousands upon thousands that protect personnel and equipment against dangerous pressure build-ups in vessels and lines containing air, gases or liquids.

When pressures rise above predetermined safe limits, this disc ruptures to provide instantaneous, unrestricted relief. BS&B designs discs to rupture at any specified pressure from 3 to 100,000 pounds per square inch. They are supplied in sizes ranging from ⅜-inch to 36 inches diameter, and in special sizes to virtually any specification.

BS&B SAFETY HEADS protect pressure systems in every type of industry

Thousands of BS&B Safety Heads have been in use for the past 26 years in virtually every type of industry where pressure protection is a problem. If your responsibility includes the *safe* operation of pressured systems in your plant, why not let us tell you more about BS&B Safety Heads?



BS&B — EFFICIENCY OVER 40 YEARS — RELIABILITY — ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

BLACK, SIVALLS & BRYSON, INC.

manufacturers of diaphragm valves, controllers, regulators, safety heads.

Dept. 2-F1
7500 East 12th St.
Kansas City 26, Mo.

Suppliers . . .

ated from The Hill School and from Cornell University with an A.B. degree in chemistry in 1922. Following some years of engineering activities in the Northwest, he first joined Hooker's sales department at Tacoma, Wash., in 1930, later becoming assistant western sales manager. He left Hooker in 1945, returning in 1950 as assistant works manager of the Tacoma plant. He became Tacoma works manager in 1951, western manager in 1952, was elected vice president in charge of western operations in 1954, and has been executive vice president since 1956.

Moffitt is president and a director of Niagara Brine Corp., a vice president and director of both Hooker Chemicals, Ltd. at North Vancouver, B. C., and Solar Salt Co. at Salt Lake City, Utah, and a director of both the National Bank of Washington at Tacoma and the Rainier National Park Co.

During the same board meeting, the directors also voted several other changes. **Ansley Wilcox 2d**, who has been secretary and general counsel, was in addition elected a vice president. **Thomas F. Willers** was elected a vice president and treasurer and will also continue as comptroller. **Dennis A. Riordan**, formerly treasurer, plans to retire. Willers, who had been assistant treasurer, succeeds him in this position. **John F. Snyder** retires as vice president but will remain as director and member of the finance committee. **J. Clarke Cassidy**, a director and former vice president, has been appointed to the finance committee, of which **Edwin R. Bartlett** is chairman. **R. Lindley Murray** continues as board chairman and chief executive officer.

POWER MACHINERY CO., Tulsa, has announced the election of **Richard Henry** to the board of directors to fill the unexpired term created by the death of **C. W. McAllister**. Henry was also elected secretary of the company.

Henry joined Power Machinery in November 1949 and has been manager of the company's Houston territory.

H. K. PORTER CO. will construct a modern tunnel kiln Refractories plant at Bessemer, Ala., as part of a one million dollar program, it was announced by **James P. Raugh**, vice-president and general manager of the Refractories Division. A general rehabilitation program at this plant, in addition to the new tunnel kiln and drier, will include new materials handling equipment and new brick making machinery.

Swindell-Dressler Corp. has been awarded the contract. Ground breaking will begin within 60 days, and completion is scheduled by Fall, 1958. The new units will utilize present clay grinding and batching facilities at Bessemer Works.

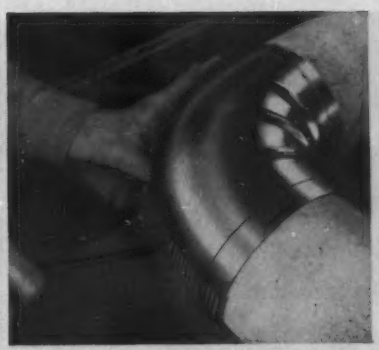
W. M. Snow, superintendent of Bessemer Works, will be in charge of the expansion program. Snow has been with Porter's Laclede-Christy Works at Bessemer since 1942.

NORTON CO. has already begun construction of an addition to its Cap-de-la-Madeleine, Quebec, silicon carbide processing plant which will increase the output capacity of the plant by 25 to 40 percent.

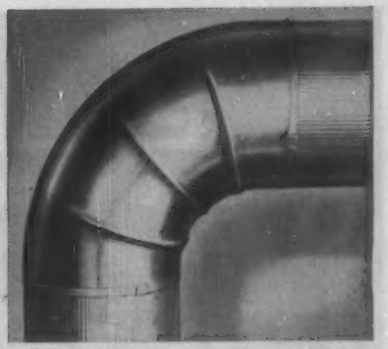
The Cap-de-la-Madeleine plant was purchased by Norton in 1949 and the first silicon carbide was produced there in

For more data on advertised products, use Readers' Service Cards, last page.

9:00 A.M. Workman places two halves of Ell-Jac over insulated elbow. Halves of Ell-Jac are held in place with wire while holes are drilled for sheet metal screws.



9:04 A.M. Screws are quickly inserted to hold Ell-Jac snugly and permanently in place. Childers Aluminum Ell-Jacs come in 23 standard sizes for both 90° and 45° long radius elbows.



9:06 A.M. Ell-Jac completely installed. When straight line aluminum weather-proof jacketing is added, lines have complete, maintenance-free protection for all costly insulation.

How New Childers Ell-Jacs Save You Time and Money

Revolutionary new Childers Ell-Jacs go on fast and easy . . . fit perfectly . . . cut installation costs . . . never need painting . . . and, used with Childers Jacketing, give your insulated lines that well-dressed look from end to end.

Now, aluminum elbows are made in a wide range of sizes by America's leading manufacturer of aluminum jacketing. Childers Aluminum Ell-Jacs are available for quick, easy application to protect costly elbow insulation.

Childers Ell-Jacs are two-piece, deep drawn from .020" aluminum, #3003 alloy. They are precision-formed for long-radius elbows and come in 23 sizes for both 90° and 45° ells.

Childers Ell-Jacs, together with Childers Jacketing, now let you install maintenance-free aluminum over every square foot of your valuable insulation. You protect *all* of your insulation investment at lowest cost. You get the bonus of a better looking plant and easier housekeeping.

Positive weather-proofing with Childers Jacketing is assured by exclusive Childers Lap-Seal (Patents Pending). You're sure of getting proper lap without waste. You save labor, too.

Factory attached moisture barrier protects both Childers Jacketing and Childers Ell-Jacs against corrosion that could otherwise damage the underneath side of the aluminum. Its slight extra cost is more than offset by savings in application labor.

You also get greater strength and greater protection because Childers Jacketing is cross-crimped. Cross-crimping increases the vertical strength and rigidity of a .016" sheet to that of a plain .024" sheet.

It's easy to install Childers Jacketing. All you need are pliers and screwdriver, plus inexpensive strapping. Two men can do the job. Jacketing can be removed for inspection of the lines, then reapplied without waste.

First cost is less for Childers Jacketing than for any other permanent type weatherproofing—even less than some temporary coverings.

You end maintenance worries, too, by using Childers Aluminum Weather-proof Jacketing and Ell-Jacs. Aluminum *keeps* its new look; needs no expensive periodic repainting.

Why not benefit from Childers world-wide experience when you buy insulation for your lines, towers, vessels, and tanks? More than 2,000 petroleum refining, petro-chemical, and chemical plants will endorse your decision. Childers Engineering Representatives, located in 27 major industrial centers, give professional advice on insulation jacketing.

For a free sample of Childers Aluminum Weather-Proof Jacketing, with engineering data on how to safeguard your insulation, write Childers Manufacturing Company, Dept. PR-41, P. O. Box 7467, Houston 8, Texas.

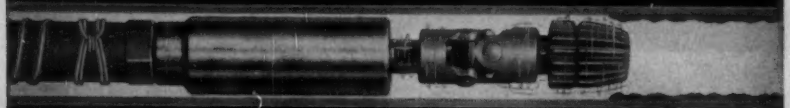
EXCLUSIVE LAP-SEAL, available at no extra cost, is a series of 8 ribs rolled into the underlapping edge of the jacketing, providing an automatic measure of the 2" circumferential lap. Proper lap is assured without waste. Labor is saved. Where desired, a positive weather seal is easily made with Lap-Seal and a mastic.

DEEP CORRUGATED Childers Jacketing in 1¼" and 2½" corrugations is recommended for permanent protection and improved appearance of insulated towers, vessels, tanks. Deep Corrugated Jacketing with factory-attached moisture barrier is another product available only from Childers.

See our ad in Sweet's Industrial Construction File, Chemical Engineering Catalog and Refinery Catalog.

For more data on advertised products, use Readers' Service Cards, last page.

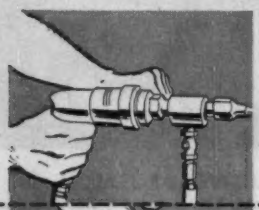
ELLIOTT
SMALL TUBE CLEANERS



types to do all jobs
quickly and effectively

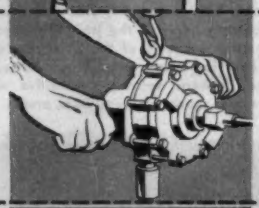
ELLIOTT 600 SERIES for small tubes—straight or curved

These air- or steam-driven motors are excellent for routing light scale in tubes with inside diameters from 5/8" to 1 3/4". Various types of cutter heads and brushes are available for specific tube cleaning requirements.



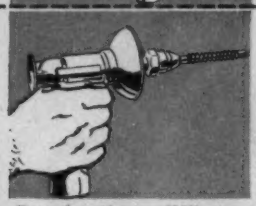
ELLIOTT 5100 SERIES lightweight cleaner for removing medium scale

Air-driven motor with trigger action for motor control, finger-action valve for water flow, built-in speed governor and oil reservoir. Two sizes.



ELLIOTT SUSPENSION SERIES for heavily scaled straight tubes

Air, steam, or electric motor drives shaft fitted with drill or brush head. Motor is suspended outside, shaft and head enter tube.



ELLIOTT JIFFY GUN for extra-fast cleaning of light accumulations

Simply insert nozzle into tube and push. Released air or water pressure shoots nylon brushes or rubber plugs through condenser or heat exchanger tubes. For tubes 1/2" to 1".

For details on Elliott tube cleaning and maintenance equipment, contact Elliott District Office or write Elliott Company, Lagonda Division, Springfield, Ohio.

Y7-1

ELLIOTT Company
Headquarters for Tube Cleaners and Expanders

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

Suppliers . . .

1951. **Howard J. Daly,** vice president and general manager of Norton's Electro-Chemical division, reported that the expansion is being made to meet the growing demands for silicon carbide for both abrasive uses and high temperature refractory applications. The new facilities should be in operation by the end of the year.

Nichols

Walthers

WESTON ELECTRICAL INSTRUMENT CORP., Newark, N. J., has announced the following appointments:

Emil Nichols as manager of test equipment sales. A graduate of Newark College of Engineering with a B.S. degree in electrical engineering. Nichols had been with Allen B. Du Mont Laboratories since 1946, serving most recently as manager of the Instruments division. A lieutenant in the United States Navy during World War II, he was an instructor in radar maintenance at Harvard University and Pearl Harbor.

A. R. Walthers as manager tachometer sales. A graduate of Purdue University with a B.S. degree in electrical engineering, Walthers had recently sold for Weston in the Cleveland territory, with prior experience in sales of industrial electronic equipment, motors and switch gear.

Heilman

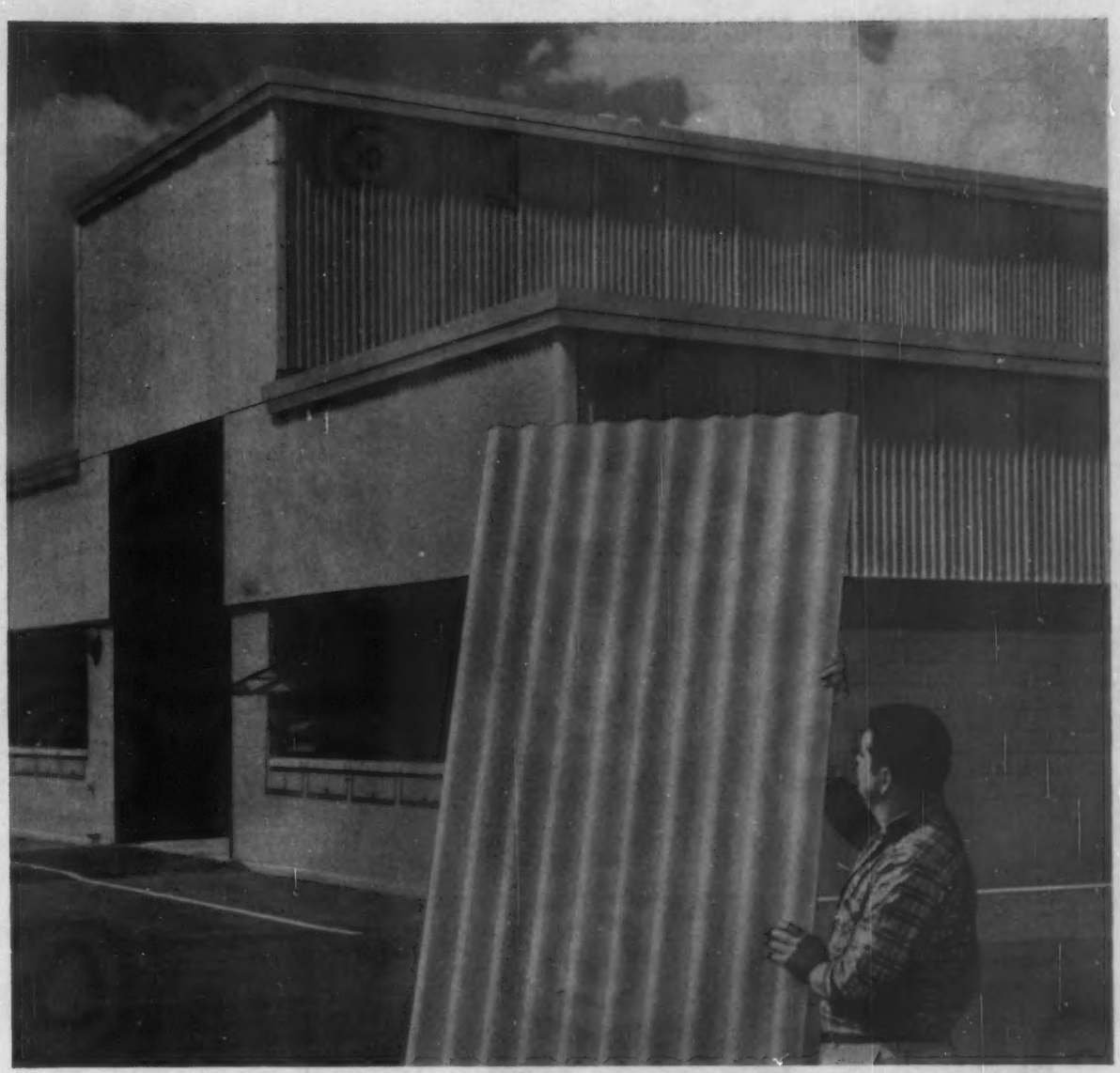
Paul M. Heilman as distributor sales manager. A graduate of M.I.T., Heilman was formerly national distributor sales manager for Reliance Electric and Engineering Co., after five years in sales with General Electric.

THE BABCOCK & WILCOX CO. has made four appointments to key positions in the Metallurgical department of the Tubular Products division. **John J. B. Rutherford,** chief metallurgist of the division's Beaver Falls plant made the announcement.

John F. Beck has been named metallurgist supervisor of technical service. His duties will include liaison on technical matters between the Tubular Products division and its customers and the industry.

Clark P. Church has become metallurgist supervisor of process development, with responsibility for supervising development of mill processes relating to new materials and methods. He continues his advisory capacity with the manufacturing departments.

Dr. John F. Ewing has been appointed metallurgist supervisor of research, with responsibility for the supervision of re-



Here's Why K&M Corrugated Asbestos Sends Your Construction Costs Tumbling!

Roof and curtain walls cost less when they're of K&M Corrugated Asbestos. Initial cost is low. Construction is inexpensive. K&M Corrugated Asbestos goes up fast —with ordinary carpenter's tools.

K&M Corrugated Asbestos is unlimited in life . . . requires little or no maintenance. It consists of asbestos fibers joined with portland cement. Stands up under all weather conditions where other materials fail. Never needs protective painting. Won't burn, rot, or corrode.

You can save money for your firm by recommending K&M Corrugated Asbestos. What does your management consider important in a building material? Attractive appearance? Economy of purchase, installation and upkeep? Durability? K&M Corrugated Asbestos has all of these features.

Write today for full information on this cost-saving material.

K·M
BEST IN ASBESTOS

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

For more data on advertised products, use Readers' Service Cards, last page.

BOOST STEAM SYSTEM EFFICIENCY! SPECIFY . . . BUY

STRONG

Hydro-Flex STEAM TRAPS

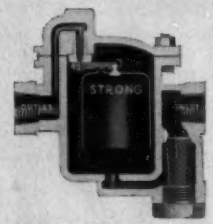
STRONG Hydro-Flex STEAM TRAPS provide all these advantages:

GREATER CAPACITY . . . thru STRONG "lever-lift" trap action
BETTER HEATING . . . thru rapid elimination of air and condensate
HIGHER EFFICIENCY . . . even under very light loads
LONGER LIFE . . . thru extra-heavy cast or forged construction
LESS WEAR . . . only two parts move — no pins on larger traps
INTERCHANGEABLE INTERNAL PARTS . . . made of tough stainless steel

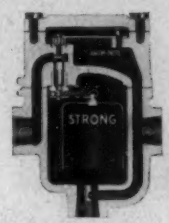
STRONG'S complete line contains a trap for every steam system: 0 to 2500 psi, 0 to 1100°F, 0 to 100,000 lbs/hour.

Horizontal, in-line traps:

140, 141, 142, 143, 144 (semi-steel): pressure-temperature limit — 250 psi at 450°F; capacities to 11,500 lbs/hour



140S, 141S, 142S (semi-steel): same as 140-142, with a built-in strainer for removing foreign matter.



140T, 141T, 142T (semi-steel): same as 140-142, with a high capacity thermal vent for faster heating

Bottom inlet, top outlet traps:

42, 43, 44, 45, 46 (semi-steel): pressure-temperature limit — 250 psi at 450°F; capacities to 42,800 lbs/hour

643, 644, 645, 646 (cast steel): pressure-temperature limit — 600 psi at 800°F; capacities to 42,800 lbs/hour

1543, 1544, 1545, 1546 (forged SAE 4130 Chrome-Moly Steel): pressure-temperature limit — 1500 psi at 950°F; capacities to 42,800 lbs/hour

642 (forged steel): pressure-temperature limit — 400 psi at 850°F; capacities to 2665 lbs/hour (not illustrated)

2544, 2545, 2546 (forged ASTM A335-P22 Chrome-Moly Steel): pressure-temperature limit — 2500 psi at 1100°F; capacities to 42,800 lbs/hour (not illustrated)

For complete information and prompt service, call your local STRONG distributor.

STRONG, CARLISLE & HAMMOND

1392 W. 3rd Street • Cleveland 13, Ohio

STRONG'S NEW CATALOG is a complete "bible" on steam specialties. Should be on every steam engineer's shelf. Write for your copy today!

air traps • strainers • vacuum or pumping traps
continuous blowdown valves • separators • engine stops • F and T traps • reducing valves

Suppliers . . .

search studies and alloy development. He continues his work as secretary of the company's Superheater Materials committee.

Thomas M. Krebs has been made metallurgist supervisor of customer service. His functions will include consultations with customers and manufacturing units on the resolution of technical problems.

Hakeman

Burrell

TRETOLITE CO., St. Louis, Mo., has announced the appointment of two new assistant division managers.

James W. Hakeman, formerly senior corrosion engineer for Tretolite at Shreveport, La., has been named assistant to the Rocky Mountain division manager, **L. C. Dessert, Jr.** Hakeman will be located at Edmonton, Alberta, and will be over Western Canada operations.

A graduate of Drake University, Hakeman was with Halliburton Oil Well Cementing Co. before joining Tretolite in 1953 as field service engineer .

James H. Burrell, Jr., formerly senior field testing engineer for Tretolite, has been named assistant to John Hampton, manager of the West Central division. Since joining the company in 1938, Burrell has worked closely, both in the field and in the laboratory, in the testing and development of new compounds. Burrell will continue to make his headquarters in Midand, Texas.

JONES & LAUGHLIN SUPPLY DIVISION has announced three appointments in the sales organization.

Robert F. Bunce, salesman, formerly at Williston, N. D., is now located at Billings, Mont.

Bill V. King, storeman at Powell, Wyo., was appointed salesman at Williston, N. D.

D. R. Duncan, storeman, Farmington, N. M., was appointed salesman at the Farmington store.

Bunce joined Jones & Laughlin Steel Corp. as a sales trainee in July, 1955, and was transferred to the Supply Division in January of 1957. He is a graduate of Rice Institute with a B.A. degree in business administration.

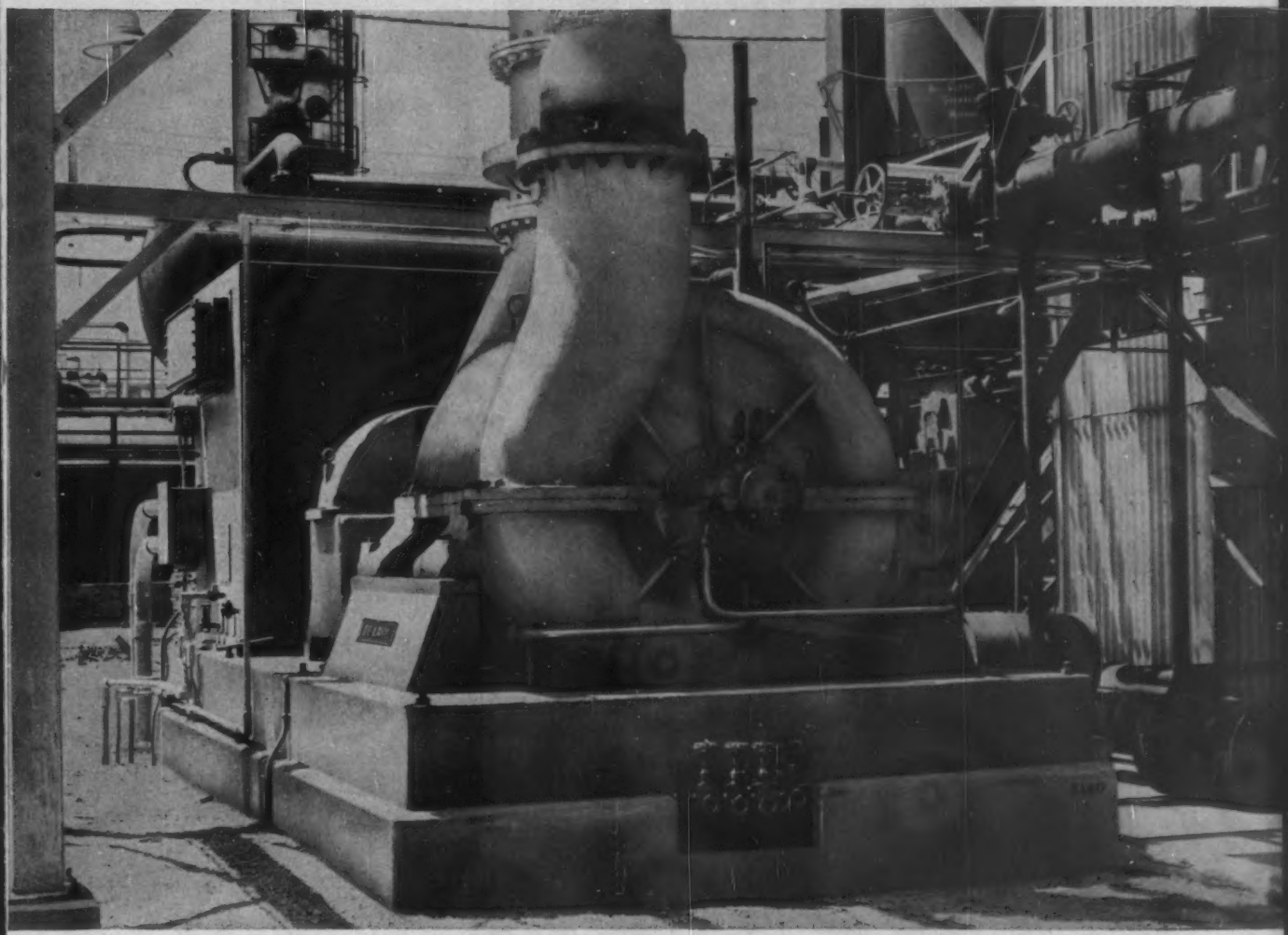
King joined Jones & Laughlin Supply Division in October, 1956 as a storeman at Powell, Wyo.

Duncan began his career at J&L in February, 1948, as storeman at Cut Bank, Mont. In August, 1957, he was transferred to Farmington, N. M.

THE DU PONT CO.'s finishes division has recently set up a new technical service sales section to be devoted exclusively to industrial maintenance painting.

The new service group will offer assistance anywhere in the country. Four district managers will be located in Philadelphia, Atlanta, Chicago, and Kansas

Another DE LAVAL *combustion air compressor dependably serves refinery cat cracker*



On stream at the Coffeyville, Kansas plant of the Cooperative Refinery Association, this De Laval Centrifugal Compressor delivers 24,100 cfm of air. Inlet pressure is 14.0 psia, discharge pressure 38.9 psia. Compressor output is controlled with adjustable inlet guide vanes.

This De Laval main air compressor is driven by a 2500 hp, 1800 rpm motor. Shaft speed is increased to 4800 rpm through a De Laval double helical speed increasing gear.

Cooperative Refinery Association is only one of many refiners who have specified De Laval Compressors. Whether you need to handle light or heavy gases at high or low pressures in catalytic cracking, reforming, alkylation, coking or any similar service, it pays to look to De Laval. Rugged De Laval centrifugal compressors perform dependably in heavy-duty continuous operation. De Laval has more than 40 years of experience in solving gas compression problems.

DE LAVAL *Centrifugal Compressors*

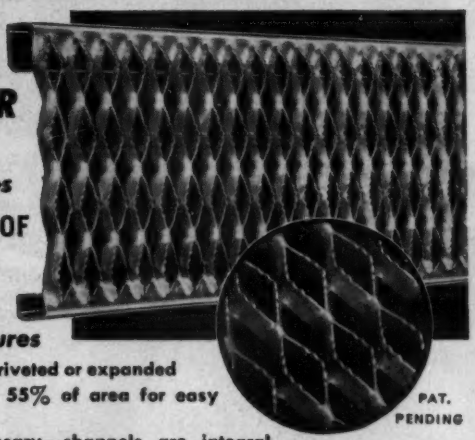
DE LAVAL STEAM TURBINE COMPANY
811 Nottingham Way, Trenton 2, New Jersey

DL-303

two superior open steel
FLOOR GRATINGS
BY GLOBE

1 Safety GRIP-STRUT®

FOR MAXIMUM SAFETY ALL OVER YOUR PLANT



Important Safety Features

★ FIRE PROOF ★ SLIP PROOF
★ MAXIMUM STRENGTH
★ MINIMUM WEIGHT

Important Economy Features

★ All one piece, not welded, riveted or expanded
★ Open space in excess of 55% of area for easy access of light and air
★ No extra supports necessary—channels are integral part of the material. ★ Self cleaning
★ Cut and installed like lumber by your own maintenance force. ★ Low in original cost. ★ For balconies, no secondary sprinkler heads needed

PAT. PENDING

Ideal for work platforms, stair and ladder steps, flooring, balconies, catwalks, machinery guards, fire escapes and for original equipment safety treads.

2 GOLD NUGGET® WELDED grating

PAT. PENDING

The QUALITY GRATING for Heavy Duty Applications

★ 3/16" projection weld nugget for greater rigidity and strength
★ Vertical alignment of the main load bar assured
★ All bars are load carrying bars including secondary bars
★ Anti-skid pattern

PROJECTION WELD

Each secondary load bar (A), as projected welded to the primary load bar (B) has a shear strength of 5,000 pounds per weld. There are 28 such projection welds to a square foot of grating. This means that GOLD NUGGET Welded Grating can sustain greater shock loads than other gratings.

10,000 POUNDS

For the complete details of these revolutionary new gratings, write for new catalogs today. Distributors in all principal cities. Consult the yellow pages in your phone book under "GRATING".

108

PRODUCTS DIVISION

The **GLOBE** *Company* MANUFACTURERS SINCE 1914

4008 SOUTH PRINCETON AVENUE • CHICAGO 9, ILLINOIS

Suppliers . . .

City. West Coast district supervision will remain with regional trade sales and industrial managers in San Francisco.

Frank Smith, formerly regional industrial manager in Kansas City has been appointed to head the new section. Smith has been with Du Pont finishes division for 29 years in laboratory and field assignments.

Jack Graham, with Du Pont since 1945, will be district manager in Philadelphia; **Herb Norton** with Du Pont for 18 years is appointed to Atlanta; **Tom Robertshaw**, 19 years, receives the Chicago post; and **Leo Hoellen**, 22 years, goes to Kansas City.

Smith's staff also includes **Jack Rode**, product manager, and **Bob Bradley**, maintenance specialist.

DAVISON CHEMICAL CO., Division of W. R. Grace & Co. has organized a Development Planning department with **O. D. Myrick, Jr.**, as director.

Myrick

Purpose of the new group is to assist in the expansion efforts of the company's product divisions; investigate areas in which the existing product structure might be extended and conduct special studies of a general management nature.

Myrick, who reports directly to **W. E. McGuirk, Jr.**, president of the Davison division, is a chemical engineering graduate of Virginia Polytechnic Institute. He joined Davison in 1942 and has served in several capacities in the company's Research and Development department, most recently as manager of development.

OLIN MATHIESON CHEMICAL CORP. has appointed **Laurence E. Russell** director of marketing for the organic chemicals division, it was announced by **Russell Hopkinson**, executive vice president.

Russell will be responsible for sales, advertising and sales promotion and sales development. He has been manager of the sales development department in the industrial chemicals division.

Hopkinson also announced the appointments of **Reid Malcolm** as sales manager; **B. N. Schrauf** as sales development manager, and **Dr. Albert H. Gower** as product sales manager.

Malcolm has held various positions with Dow Chemical Co. and R. N. Hollingshead Corp. Schrauf formerly was assistant manager of market development for Olin Mathieson's industrial chemicals division and Dr. Gower has held various administrative posts at American Cyanamid Co. and Sun Chemical Corp.

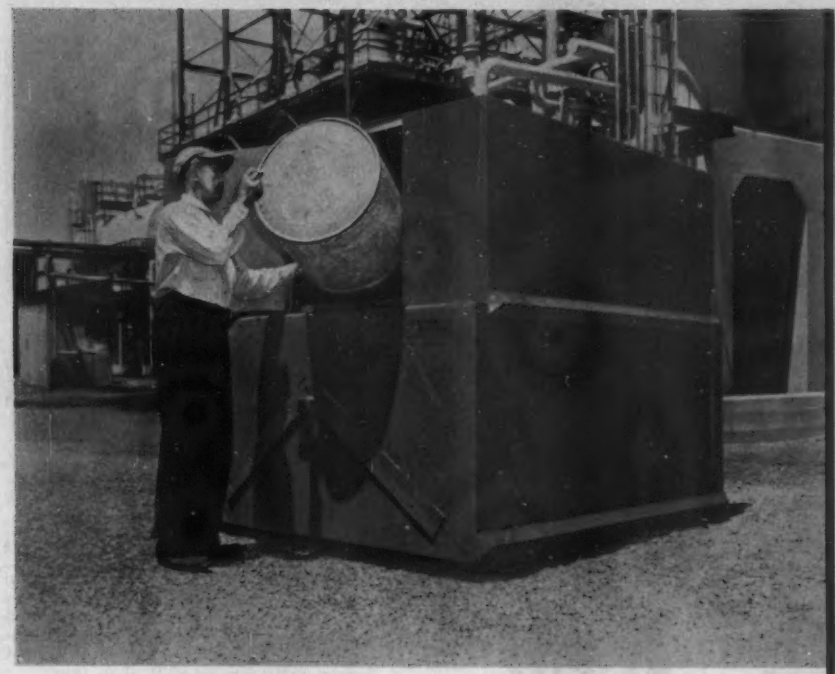
MANDREL INDUSTRIES, INC., has appointed **W. W. Greene** production manager and **D. A. Saunders** assistant production manager.

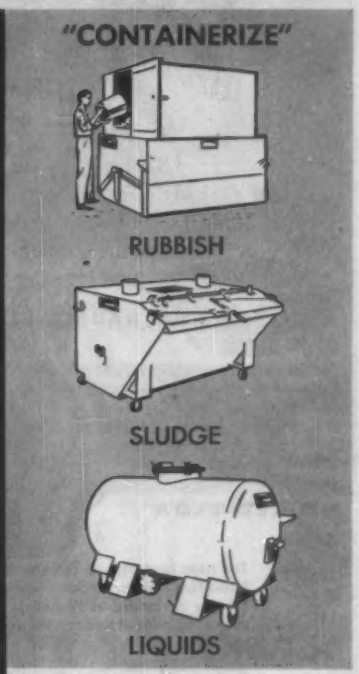
Greene, a graduate of Milwaukee School of Engineering, was plant manager for Electric Sorting Machine Co. prior to this division's move to Houston. In Houston he was assistant production manager.

Don Saunders, formerly in charge of the assembly section at Mandrel, is a graduate

For more data on advertised products, use Readers' Service Cards, last page.

"CONTAINERIZE" Waste and Rubbish in FIRE-PROOF...WIND-PROOF Dempster-Dumpster Containers





One-Man Waste and Rubbish Collection System Cuts Costs...Reduces Fire Hazards

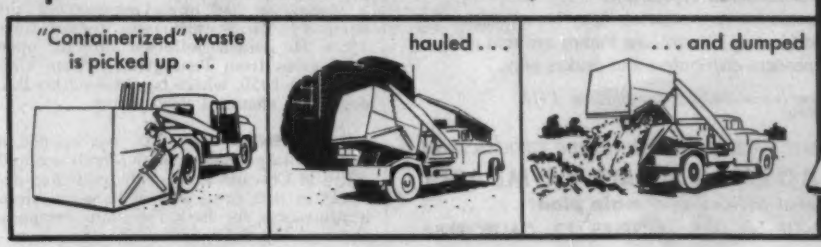
Unsightly trash heaps, open drums and knocked-over trash cans let rubbish scatter and blow . . . they constitute a fire hazard that the petroleum industry cannot afford. That's why leading processors and refineries keep premises spotless by "Containerizing" waste *as it accumulates*. Big, clean Containers, placed at points of accumulation, provide temporary, enclosed storage for all types of waste. One man, driving a truck-mounted Dempster-Dumpster, picks up the filled Containers, hauls, dumps and returns them on a planned shuttle schedule. Savings are obvious . . . the System generally pays for itself in less than 18 months.

WRITE TODAY FOR FREE MANUAL,
"How to Cut Disposal Costs"

Dept. PR-1 DEMPSTER BROTHERS, Knoxville 17, Tenn.

PARTIAL LIST OF USERS

Cities Service
Cosden Petroleum Corp.
Esso Standard Oil Co.
Ethyl Corp.
Great Northern Oil Co.
Gulf Oil Corp.
Humble Oil Refining Co.
Lion Oil Co.
Pan American
Phillips Petroleum
Shell Oil Co.
Sinclair Refining Co.
Socony-Vacuum Oil Co.
Standard Oil
Sun Oil Co.
Sunray Oil Corp.
The Texas Company
Tidewater Oil Co.



THE DEMPSTER DUMPSTER® SYSTEM

Verti-Line® Pumps

offer your choice of impellers

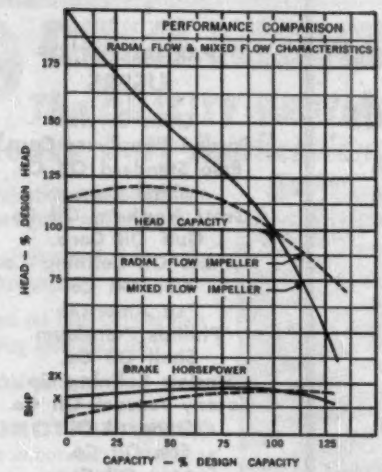
To meet a wide range of exacting pumping conditions, Verti-Line Close-Coupled Industrial Pumps are available with two impeller types.

RADIAL-FLOW

The flat head capacity characteristic of the Radial-Flow impeller is applied to systems such as fueling, condensate return, and cooling towers, which operate at constant pressure against varying capacities and under throttled conditions.

MIXED-FLOW

The steep head-capacity characteristic of the Mixed-Flow impeller is applied where constant capacity is required at fluctuating pressures such as pipeline pumps or units operating in parallel or series.



CAPACITIES from 20 GPM to 30,000 GPM

— HEADS to 600 PSI

There's a Verti-Line Pump designed to fit your particular application.

Whatever your needs for vertical pumps may be, investigate Verti-Line before you buy! Verti-Line Pumps are sold and serviced by independent distributors and dealers only.

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Verti-Line Pumps are the exclusive products of

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Suppliers . . .

of Oklahoma A. & M. with a B.S. degree in electronics. He was with the U. S. Army Engineers as well as having been a field observer for a seismograph exploration company in Texas.

Stuntz

Forsyth

THE BABCOCK & WILCOX CO. has appointed **Robert P. Stuntz** assistant sales manager of the company's Refractories division, it was reported by **James E. Brinckerhoff**, vice president.

Succeeding Stuntz as manager of the division's Chicago district sales office is **Robert H. Forsyth**, it was reported by **Mark J. Terman**, sales manager for the division.

Stuntz joined B&W in 1940 as a plant engineer at the company's Augusta, Ga., works. After serving as a lieutenant in the Navy from 1942-46, he resumed his duties at Augusta, before being transferred in 1946 to Chicago. He was appointed assistant district sales manager in 1950, and district sales manager the next year.

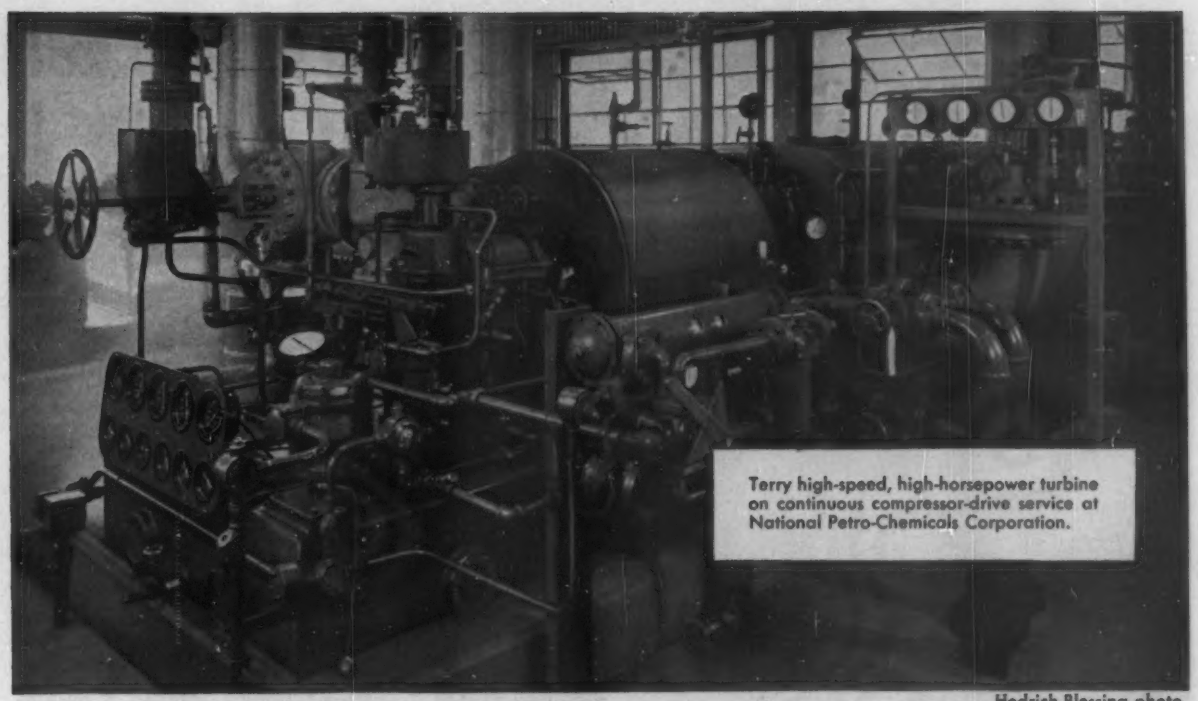
Forsyth began his B&W career in 1946 as a student engineer. One year later, he was transferred to the Refractories division, where he spent five years in the engineering and service departments. He was assigned to the New York district sales staff in 1952, and to the Pittsburgh district sales office in 1953. Forsyth is a graduate of Lehigh University.

JEFFERSON CHEMICAL CO. has appointed **J. R. Carlson** to the newly created position of sales manager it was announced recently by **D. L. Griswold**, generral manager of the company's Marketing Department. At the same time announcement was made of the appointment of **P. R. Monaghan** as regional manager of the Eastern Region.

Carlson, a 1940 graduate of Columbia University, has been Jefferson's Eastern regional manager since 1956. He joined the company in 1951 as a salesman and later was district sales manager for the Chicago and then the New York area. Prior experience included two years as a research chemist for United States Industrial Chemicals Co., and four years with the Solvay Process Division, Allied Chemical and Dye Corp., where he was technical assistant to a product sales manager.

Monaghan has been manager of the company's Technical Service division since 1955. He joined Jefferson directly upon graduation from Pennsylvania State University in 1950, where he obtained his B.S. degree in chemical engineering.

THE CARPENTER STEEL CO. has opened a new and larger mill branch warehouse and office in Chicago to meet the increased demand in that area. It will be midwestern headquarters for both the main company and its Alloy Tube division. The new instal-

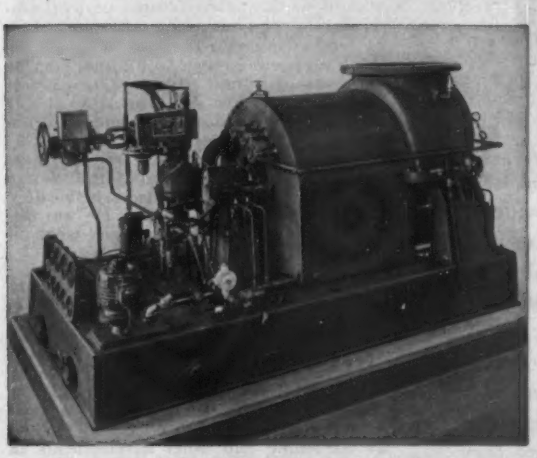


Terry high-speed, high-horsepower turbine on continuous compressor-drive service at National Petro-Chemicals Corporation.

Hedrich-Blessing photo

At National Petro-Chemicals Corporation . . .

Terry high-speed compressor-drive turbines provide continuous 'round-the-clock service



One of the two 5400 hp., 7486 rpm turbines built for the Tuscola plant of National Petro-Chemicals Corporation.

In the fall of 1953, five Terry multistage turbines were placed on day-and-night duty at the Tuscola, Illinois, Plant of National Petro-Chemicals Corporation. They drive high-speed compressors used to compress hydrocarbon gases in the production of ethylene.

The *excellent performance of these initial units later resulted in the installation of two more Terry machines.* These were placed in service some two years later.

In all, the seven turbines total more than 30,000 hp. They range in capacity from 3300 to 5400 hp., and in speed from 7500 to 9700 rpm.

The National Petro-Chemicals installation, and the thousands of other units serving in refineries and chemical plants throughout the world, are testimony to the low maintenance and consistent reliability of Terry turbines. Put Terry to work for you. Write for further information.

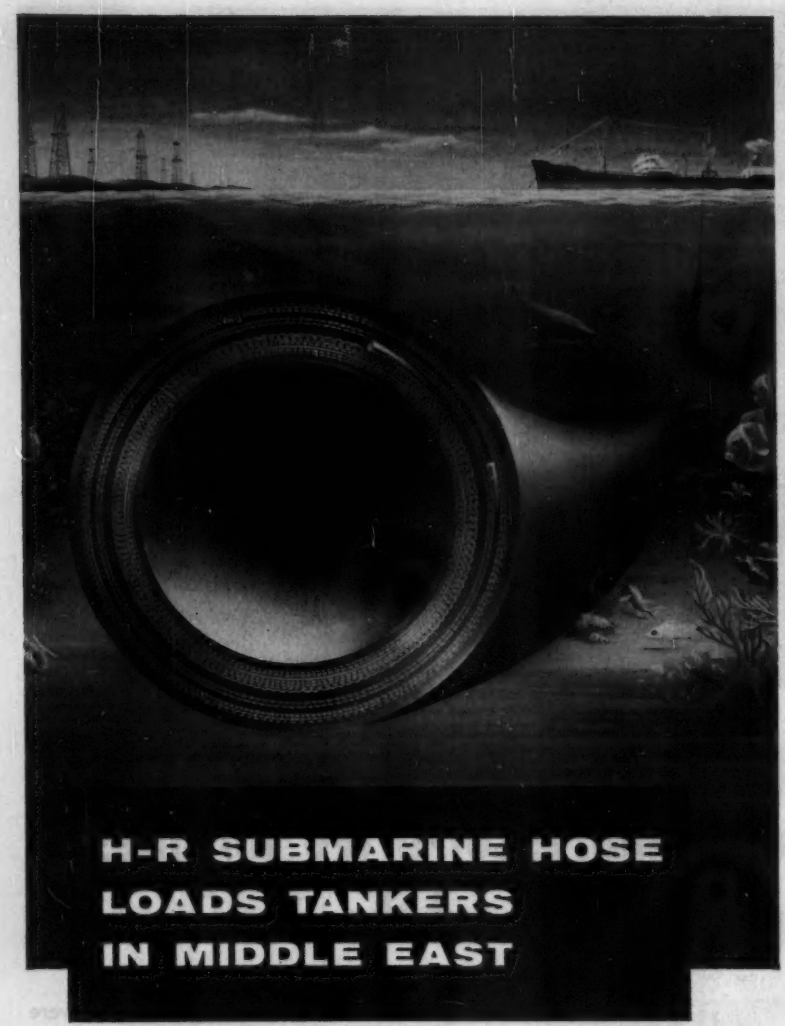
THE TERRY STEAM TURBINE CO.

TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1207

For more data on advertised products, use Readers' Service Cards, last page.



During several years of Eastern Mediterranean service for the Trans-Arabian Pipe Line Company, three lengths of Hewitt-Robins 12" Submarine Hose have loaded 1,295 tankers with 169,334,955 barrels of oil. Another length, in service six years, has loaded 1,603 ships with 232,713,229 barrels. This remarkable record is evidence of the extreme strength and flexibility of this sea loading hose. For it withstood constant flexing by wave-tossed tankers, the abrasive action of sand and silt, and the corrosive action of oil and salt water.

Also from Trans-Arabian come test reports of Hewitt-Robins 15¼" I. D. Submarine Hose. Results: increased loading capacity for today's super tankers. To find out how H-R products and services can help you, consult your classified telephone directory for the nearest H-R representative, or contact Hewitt-Robins, Stamford, Connecticut.

HR HEWITT-ROBINS

CONVEYOR BELTING AND IDLERS...POWER TRANSMISSION DRIVES
INDUSTRIAL HOSE...VIBRATING CONVEYORS, SCREENS & SHAKEOUTS

Suppliers . . .

lation replaces a former warehouse operated by the firm in Chicago for the past 30 years.

The following sales executives will manage operations out of the new headquarters: **Paul W. Holtz**, district manager; **W. J. Stephens**, branch manager, and **John R. Seward**, warehouse manager. **Walter A. Baumstark** is midwest regional manager for the Alloy Tube division.

A. W. CASH CO., Decatur, Ill., has appointed Thermal Industrial Engineer Co., Denver, as Colorado representative for the Cash Standard and Cash Standard Stacon lines of pressure, temperature, hydraulic, process and combustion controls.

BLAW-KNOX CO., Pittsburgh, has appointed **Robert E. Walsh** regional vice president of the company in the Chicago area. The new position was established, according to **W. Cordes Snyder, Jr.**, president to consolidate responsibility in the area served by the company's three Chicago sales offices.

Walsh

Walsh will continue to supervise roll sales activities in the Chicago area, a position he held prior to his new appointment. A native of Chicago, Walsh graduated from the University of Chicago in 1932 with a B.S. degree. He has been associated with Blaw-Knox since 1937.

FLUOR CORP., LTD., has appointed **Edward McNary** controller and assistant secretary. He succeeds John Schuler who has been named to the newly created post of controller for the Fluor Corp., of Canada, Ltd.

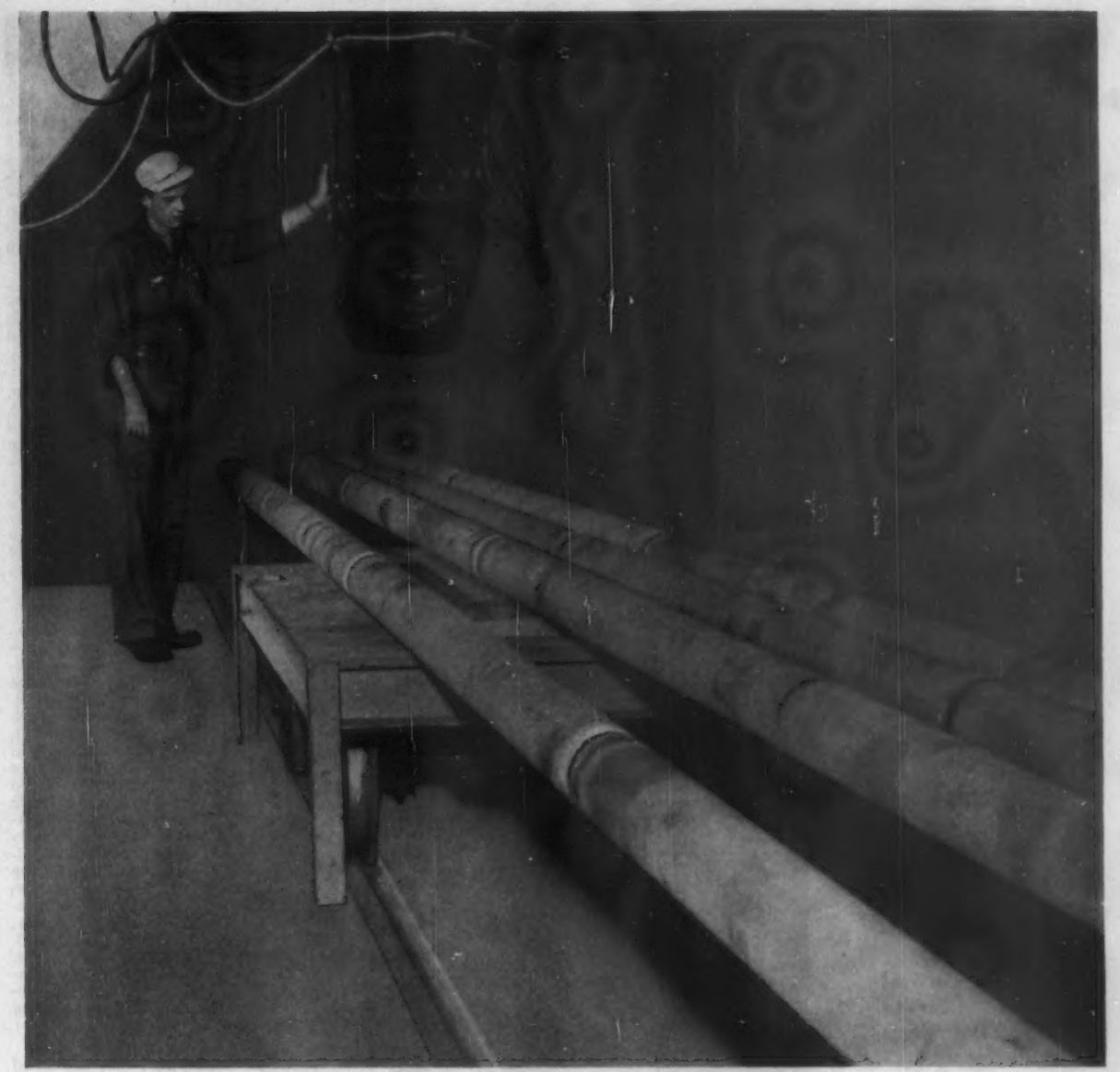
Before joining the Los Angeles based firm, McNary had been with Ford Motor Co., for five years. His most recent assignment was assistant controller and assistant treasurer for the Ford subsidiary, Aeronutronics Systems, Inc., Glendale, Calif.

He served in the Auditor General's office of the U. S. Air Force from March 1941 to March 1946, and was recalled to active duty during the Korean hostilities. He was discharged with rank of Major and went directly to Ford.

LEEDS & NORTHRUP CO., Philadelphia, announced that **George W. Tall, Jr.**, vice president & secretary, and a director, has retired after 42 years with the company. He graduated from Cornell University in 1913, and joined L&N two years later, as a service man. In his early years he was largely concerned with the Hump Method of hardening and other developments in the metallurgical-furnace field, and was later manager of various sales operations of his company.

GENERAL ELECTRIC CO. has appointed **Robert L. Grunewald** as manager-manufacturing for the company's Gas Turbine department, according to **John P. Keller**, department general manager.

A native of Amsterdam, N. Y., Grunewald joined General Electric in 1936 and three years later he graduated from the Apprentice Course and entered Purdue

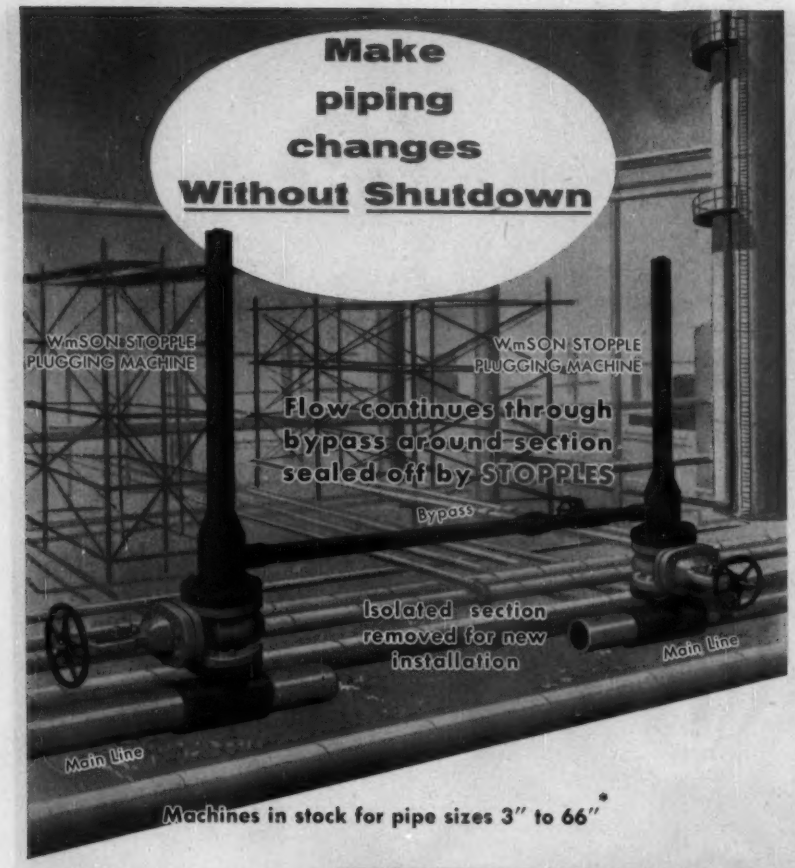


"Double and redoubled inspection" to guarantee leak-proof service— ELECTRO-ALLOYS Reformer Furnace Tubes!

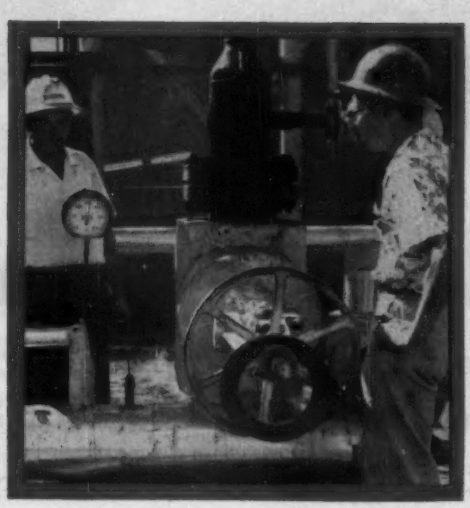
Individual tubes are *hydrostatically* tested. Tubes are *dy-cheked* after every weld pass. Complete assemblies are *X-rayed* and then given a final *pressure test*. This is positive protection against leaks that might some day save you a fortune. Add greater density, finer grain structure, uniform wall thickness... and you understand why Thermalloy* centrifugally cast tubes are preferred. When you think in terms of tubes, think Thermalloy... and put Electro-Alloys' long metallurgical experience in heat-resistant alloys to work for you. Call your nearby representative—or write Electro-Alloys Division, 9071 Taylor Street, Elyria, Ohio. *Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION • Elyria, Ohio



Large inland Refinery tests 8" Stopple in steam line at 475° F. Held 160 PSI pressure 5 days without leakage.



Machines are for steel or cast iron pipe containing:
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• Gasoline • Water • Propane

Write for article reprints telling how Plants and Pipeline Companies use WmSon STOPPLES and TAPPING MACHINES.

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REPRESENTATIVES: HOUSTON • AMARILLO • PITTSBURGH • JOLIET, ILL. JACKSON, MICH. • LOS ANGELES • SAN FRANCISCO • BARTLESVILLE, OKLAHOMA • SEATTLE • SALT LAKE CITY • EDMONTON • TORONTO WINNIPEG • VANCOUVER • BUENOS AIRES • CABIMAS, ZULIA, VENEZUELA • DURBAN, NATAL, S. AFRICA • PARIS, FRANCE • SIDNEY, AUST.

Suppliers . . .

University. In 1943 he received a B.S. degree in mechanical engineering and rejoined the company.

From 1943 to 1945 he served as a technical engineer at General Electric's Lynn River Works. From 1945 to 1947 he was a member of the advanced manufacturing program and in 1947 he transferred to the jet engine production organization.

In 1955 Grunewald was named manager-Component Manufacturing & Engine Rebuild-Production Engine department at Evendale, and retained this position until this present appointment.

WESTON ELECTRICAL INSTRUMENT CORP. is expanding its sales and service facilities in the West with the addition of a new district sales office and repair facility in San Francisco at 147 10th Street. Weston is a subsidiary of Daystrom, Inc.

For the past 20 years, the northern California business has been handled by **Herman E. Held,** manufacturer's representative. This representative's entire staff is now devoting full time to Weston's sales and service.

THE PETRECO DIVISION, Petrolite Corp., has named **Logan C. Waterman** as sales manager. He will succeed **I. S. Boydstun** who recently resigned. Starting in the engineering department, Waterman has been with Petreco since 1926. He has held various technical and administrative positions. He has recently completed a round-the-world trip during which he visited Petreco clients and installations in Japan, the Philippines, Middle East and Europe.

Waterman

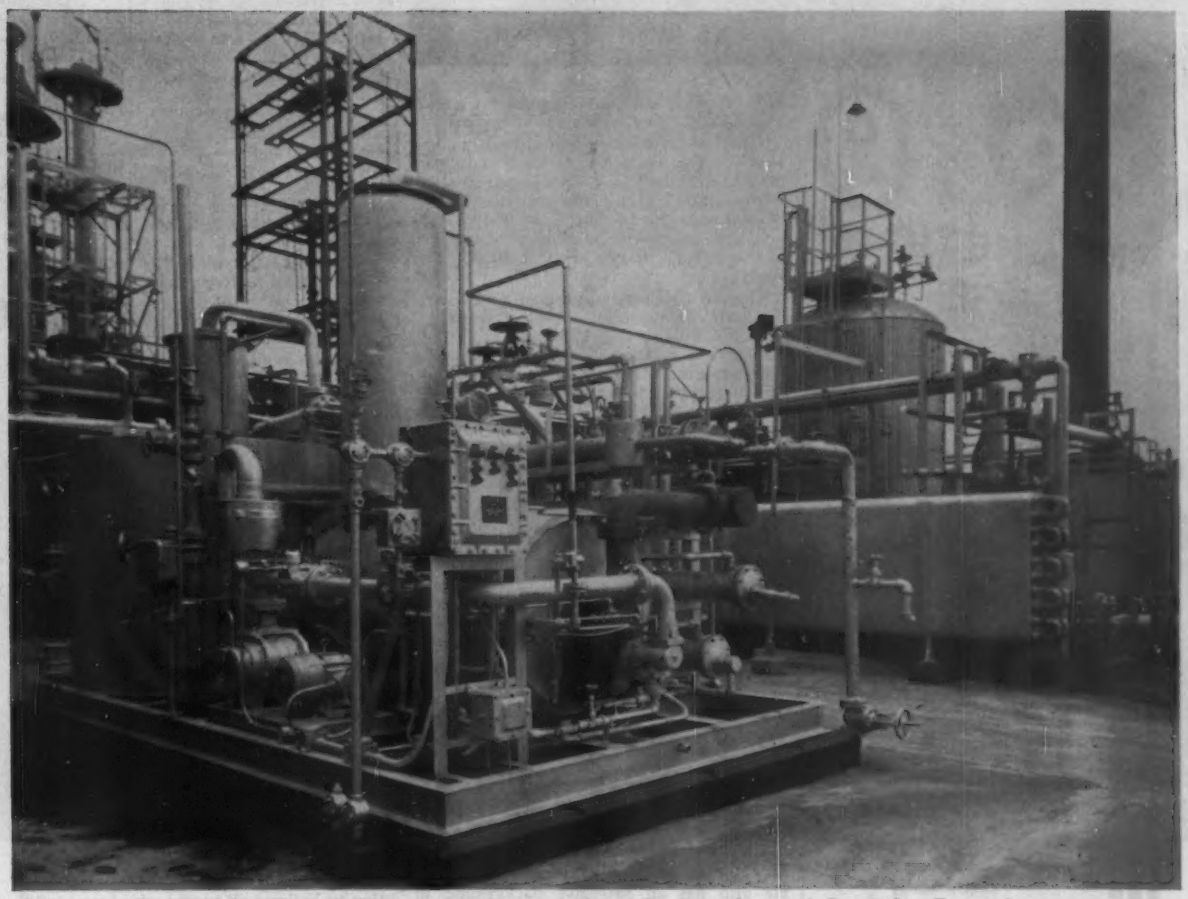
Waterman was graduated by Rice Institute, Houston, with an Engineering degree. He served in the Air Force during World War II.

AMERICAN CYANAMID CO. has appointed **J. G. Affleck** manager and **R. W. McCullough,** sales manager, for the rubber chemicals department of the Organic Chemicals division.

A graduate of Princeton University, Dr. Affleck joined Cyanamid in 1949 as a chemist in the company's Stamford, Conn. laboratories. He has served since 1955 as manager of Cyanamid's new product development department.

McCullough, a graduate of the Case Institute of Technology in Cleveland, has been with Cyanamid since 1950 when he joined the company as a sales representative. Since early this year, he has been manager of technical services for the rubber chemicals department.

BECKMAN/SCIENTIFIC INSTRUMENTS DIVISION, Fullerton, Calif., has appointed **Elwood F. Blondfield** product line manager of the electrochemical and gas analysis instrument groups. He was formerly product sales supervisor of gas analysis instruments. Blondfield has a B.S. degree in chemistry and a year of graduate work at UCLA. He taught electronics for current



Gas Atmospheres built combination generator in operation at The Texas Company's Port Arthur, Texas refinery.

Gas Atmospheres Generator Sees Double Duty At The Texas Co. Refinery

COMBINATION NITROGEN/CO_2 PLANT ECONOMIZES PRODUCTION OF OIL ADDITIVES

HERE's the Gas Atmospheres' combination generator that has petroleum engineers talking. Recently installed by The Texas Company at their Port Arthur, Texas refinery this highly versatile generator produces continuously high purity nitrogen and carbon dioxide at the same time . . . and, at the cost of producing either gas alone. The unit pictured is designed to produce 10,000 c.f. of nitrogen and 150 lbs. of CO_2 per hour. Gas Atmospheres plants of this type can be built to produce up to 40,000 c.f. of nitrogen and 600 lbs. of CO_2 per hour.

Highest Safety Factors

Designed for outdoor installation the unit features nozzle mix combustion for highest safety. This design permits the use of the widest possible range of fuels for burning.

Built on a common base, this compact unit was completely factory tested prior to shipment and quickly and easily installed at minimum cost.

The complete installation includes compressors and drying equipment engineered by Gas Atmospheres.

gas Atmospheres, inc
equipment for producing industrial gases
20011 WEST LAKE ROAD CLEVELAND 16, OHIO

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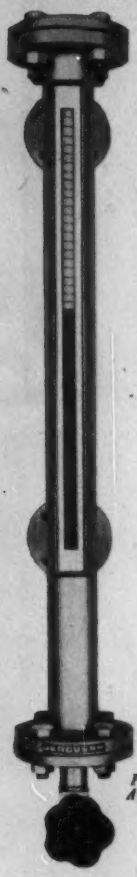
Announcing
the New
Jerguson
MAGNETIC GAGE
For Liquid Levels



An important advancement in liquid level observation for plants with dangerous explosive or inflammable conditions.

Safety design seals against escaping gases.

Measuring mechanism in stainless steel chamber.

Scale mounted outside chamber; magnetically actuated through chamber wall.

Distinct, accurate level shown in red contrasted with silver above.

Job designed, correlating pressure, temperature, and specific gravity.

For pressures up to 2500 lbs. @ 600° F.

Patent Applied For

Can also be used for interface indication.

Write now for engineering sheet on Jerguson Magnetic Gages.

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Gages and Valves for the Observation of Liquids and Levels
JERGUSON GAGE & VALVE COMPANY
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Offices in Major Cities
In Canada: Peacock Bros. Ltd.

Suppliers . . .

airborn radar computer systems for a year and a half before joining Beckman in 1953.

Charles D. Kennedy has been named new product specialist. He will assist customers in sales and service and provide necessary technical assistance. Kennedy did laboratory work for the I. H. Flour Mills in Topeka prior to joining Beckman. He holds a B.S. degree from Kansas State College.

David C. Nelson, also recently made new product line specialist in the gas analysis group, will work with customers requesting application and technical information on chromatographs and other gas analysis instruments. Nelson was formerly with the department of chemistry at Purdue University and also worked in Navy research at Port Hueneme, California. He has an M.S. degree in analytical chemistry from the University of Minnesota and is a member of the American Chemical Society.

Samuel H. Ashworth was appointed infrared product specialist. Ashworth was formerly a physicist at the Akron Goodyear Tire and Rubber Co. for two years and a spectroscopist for the Callery Chemical Co. for over three years, before joining Beckman. He has a B.S. degree in chemistry from Stanford University.

MANNING, MAXWELL & MOORE, INC., recently announced the appointment of **Jack S. Verhaeghe** as technical advisor—European area.

Lately with one of the company's present licensees and sales agents, Atelier Jaspar, S.A., Liege, Belgium. Verhaeghe has been connected with manufacturers of instruments as sales engineer since 1946. He also has an extensive background in all types of instrument engineering. He graduated in 1942 from the University du Travil, Charleroi, Belgium.

NATIONAL ALUMINATE CORP. recently moved through another phase of major expansion with the completion of an addition that more than doubles its administrative and laboratory facilities.

Total office, laboratory, manufacturing and warehouse area for the chemical firm's main operation now exceeds 365,000 square feet, on property covering 16 acres.

The Nalco organization also includes seven other manufacturing sites in the U. S., Canada and Europe.

WESTINGHOUSE ELECTRIC CORP. has appointed **John L. Cross** industrial sales manager for the corporation's Atlantic apparatus sales region in Philadelphia, Pa.

Cross entered the Westinghouse student training course in 1933 after graduating from Iowa State College with a B.S. degree in electrical engineering. He later held various sales posts in the New York sales office and the transformer division in Sharon, Pa.

In 1941 Cross became manager of power equipment sales at the Sharon works, and in 1957 until his present assignment he served as assistant sales manager of apparatus products at Westinghouse headquarters in Pittsburgh.

THE FLORI PIPE CO. and **Houston Pipe Steel, Inc.,** as subsidiaries of the Sparton Corp., have appointed **Kenneth E. Martin** to head the new Western district sales office.

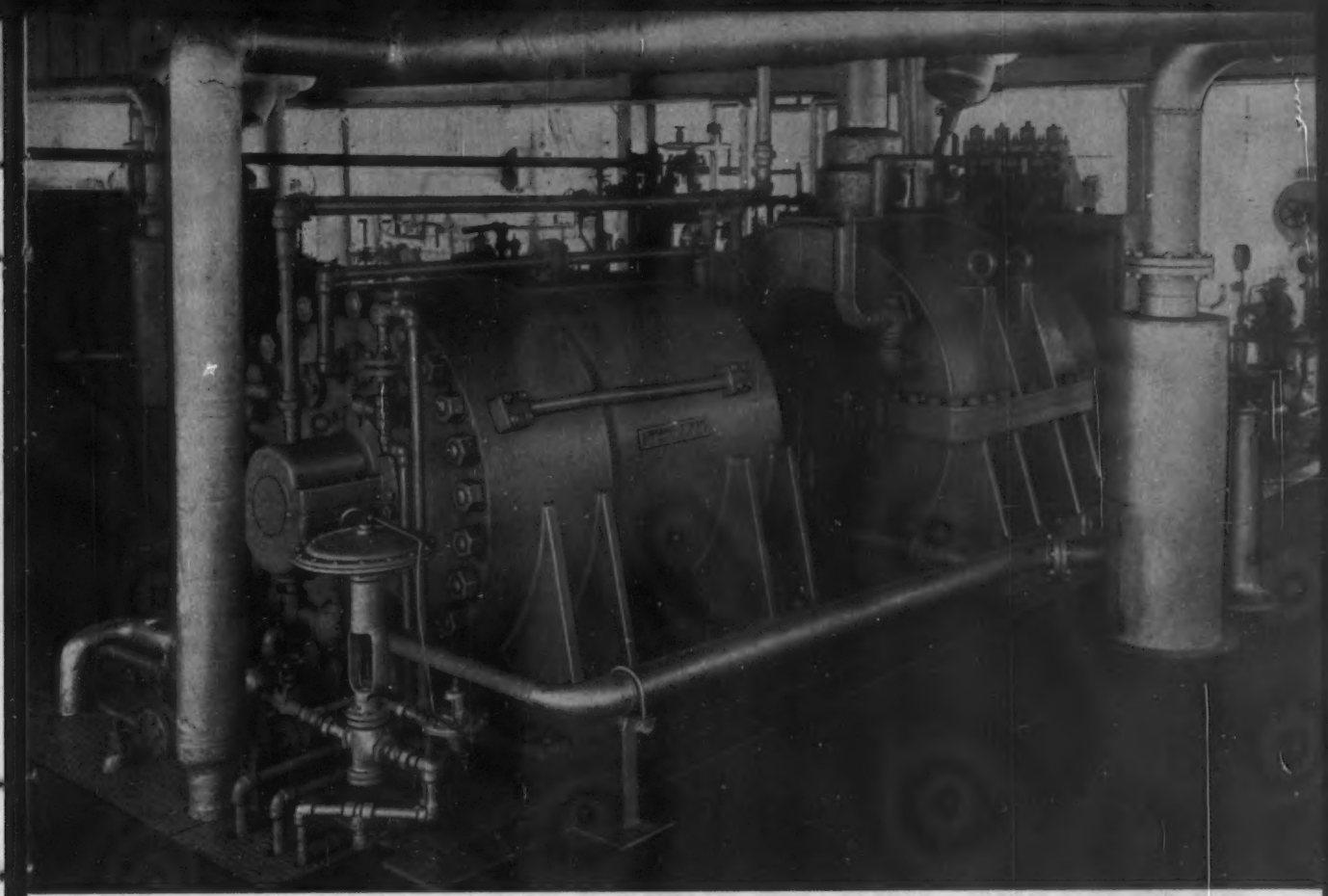
Martin's appointment as district sales manager is part of the new Flori-Houston national sales team. Martin was educated at the University of Texas and several Air Force technical schools before joining Houston Pipe and Steel, Inc., in 1953. He served in both the engineering and sales departments with Houston Pipe and Steel, Inc.

THE BABCOCK & WILCOX CO. announced that its boilers will power one of the world's most complete air conditioning systems, at Dallas' new, $7.5-million Love Field Terminal.

MIXING EQUIPMENT CO. now has in operation a specially-designed new fluid agitation research laboratory which will help solve basic petroleum industry problems in the mixing, blending and separating of solvents and other Class I, Group D materials.

The new hazardous materials laboratory features a complete pilot mixing plant which can test run up to 600 gallons of flammable or non-flammable substances simultaneously, in either batch or continuous process.

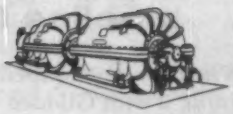
Dr. James Y. Oldshue, research director



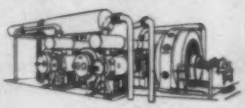
Putting the PRESSURE on low-grade naphthas to make high octane blending stocks

THE Ingersoll-Rand centrifugal compressor shown here handles hydrogen gas at high pressure – 5050 cfm at 675-psia discharge pressure. Driven by a 6340-hp I-R steam turbine, it is one of two duplicate machines installed as recycle compressor on a large catalytic reforming unit. This same refinery uses 19 additional I-R compressors.

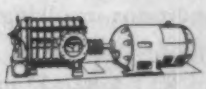
Ingersoll-Rand compressors are industry's first choice for high-pressure operation. Centrifugal compressors like the one shown here are now operating at pressures over 2,000 psi; I-R reciprocating compressors have been sold for pressures as high as 35,000 psi. So if your process calls for *putting on the pressure* you'll want to look into the complete line of I-R compressors. There's one that will be *just right* for your application. If necessary, a compressor can be designed specially for your application. Ask for your copy of form 3132-A, Process Compressors.



CENTRIFUGAL



RECIPROCATING



AXIAL-FLOW ROTARY

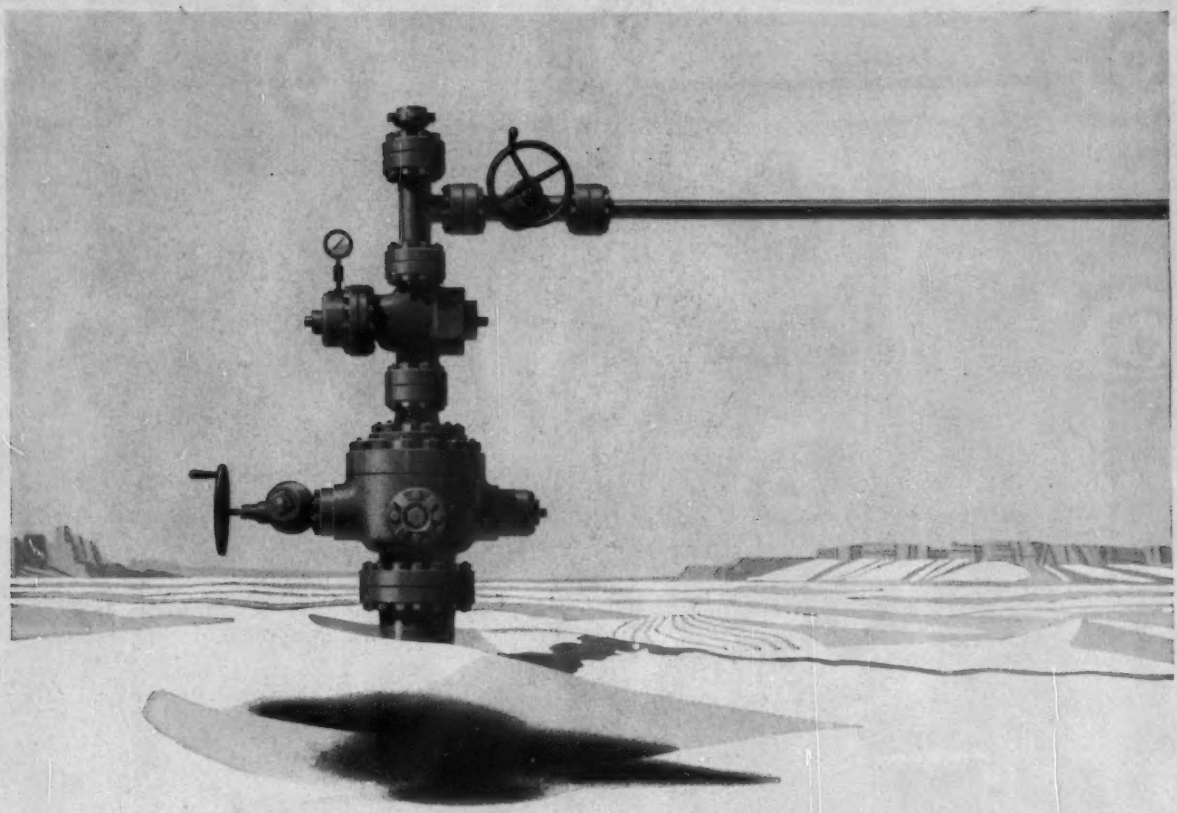
EJECTOR-JET

The World's Most Complete Line of Compressors

Ingersoll-Rand

12-720 11 Broadway, New York 4, N. Y.

PUMPS • COMPRESSORS • DIESEL ENGINES • AIR & ELECTRIC TOOLS • TURBO BLOWERS • CONDENSERS



GLIDDEN NU-PON COTE LININGS

...the unseen sentinels that guard against pipeline failure and needless loss!

When you put a pipeline out of sight, you can put it out of mind also by lining it with Glidden NU-PON COTE*. These superior linings offer outstanding adhesion to iron, steel, aluminum, plastics, masonry and galvanized iron. And, they perform equally well on tank cars and storage tanks.

Glidden NU-PON COTE provides excellent parafine release plus maximum resistance to highly-corrosive sour crude, natural gas, chemicals, water and abrasion. In addition, it is particularly good in operating conditions involving the majority of concentrated solvents.

Besides NU-PON COTE, Glidden offers the VINYL-COTE*, VYN-AL* and NEV-A-RUST* maintenance coating systems, each specifically engineered to offer positive corrosion control at lowest cost per square foot per year.

*A Glidden Trade-Mark

Write today (company letterhead, please) for your copy of this new book which contains complete information on all Glidden Maintenance coatings.

THE GLIDDEN COMPANY
INDUSTRIAL MAINTENANCE HEADQUARTERS
900 Union Commerce Bldg. • Cleveland 14, Ohio

QUALITY Glidden PRODUCTS

SALES OFFICES AND FACTORIES: San Francisco, Los Angeles, Chicago (Nubian Division—1855 North Leclaire Ave.), Minneapolis, St. Louis, New Orleans, Cleveland, Atlanta, Reading. In Canada: Toronto and Montreal.

Suppliers . . .

of the firm, states that the hazardous materials laboratory was built for two reasons: 1) to provide the petroleum industry with quick and correct answers to preliminary testing problems of blending, mixing and separating in the refineries. 2) to conduct "blue sky" research as part of the company's planned growth pattern.

NATIONAL ALUMINATE CORP. recently moved through a third phase in its two year major expansion program with the completion of a $1.5 million addition to its administrative and laboratory facilites.

Total office, laboratory, manufacturing and warehouse area for the chemical firm's main operation now exceeds 365,000 square feet, on property covering 16 acres.

The Nalco organization also includes eight other manufacturing sites in the U. S., Canada and Europe.

WESTINGHOUSE CORP. has announced that a modern new jet fuel storage and handling system has been completed at its aviation gas turbine division plant in Kansas City. Two steel storage tanks with a capacity of 840,000 gallons; eight unloading stations; a cooling tower for temperature control; a special fire extinguishing system; and, a push-button control station are included in the modern facility.

Up to 20 railway tank cars an hour can be handled by six new unloading stations. Two additional stations are equipped to unload fuel from transport trucks. Telescopic bridges permit rapid unloading and provide workmen with maximum safety, according to **L. M. Henderson,** manager of operations at the Westinghouse plant.

BECKMAN INSTRUMENTS, INC., has appointed **Stanley F. Molner** to the post of product line sales supervisor, Data Handling Equipment, Systems division.

Before assuming his new responsibilities at the Richmond, Calif., plant, Molner was employed by Marchant Research, Inc., as a senior systems analyst on computers. Prior to that, he was a senior engineer, data and control systems, for the Armour Research Foundation and the Victor Adding Machine Co. Molner was also an electronic engineer for nuclear and physiological research at the University of Chicago; a research engineer, temperature, dew point, and air velocity meters, for the Illinois Testing Laboratories; and an electronic technician for the United States Navy.

Molner graduated from Northwestern University in 1945 with a B.S. degree.

WORTHINGTON CORP.'S home air conditioning and heating equipment sales will be handled by the corporation's Mueller Climatrol Division under a new policy announced by **Walther H. Feldman,** president of Worthington.

Sales to the commercial and industrial markets will continue to be handled by Worthington's Air Conditioning and Refrigeration Division.

Elston J. Tribble, group vice president of Worthington, will administer the overall operations of both divisions and coordinate their marketing activities.

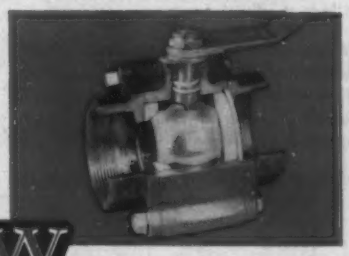
OLIN MATHIESON CHEMICAL CORP. has announced that **George A. Waterman** has joined the company as director of product sales and engineering for Olin Aluminum.

Worcester's New Econ-O-"Miser" Ball Valve is BOTH*

VALVE and UNION

This great new advance in valve design can mean substantial savings for you. Its unique construction makes the Econ-O-"Miser" both ball valve and union in a line whether the application be original equipment, in-plant maintenance or process lines.

The costs of a union and installing it are eliminated, resulting in tremendous savings when the number of ordinary valves and unions in even a small installation is considered. Add to this the longer operating life of the Econ-O-"Miser", the time and materials savings of *in-line maintenance,* and you get performance unmatched by *any* valve at *any* price.



The Econ-O-"Miser" is available in Bronze, Aluminum, Aluminum Bronze, Forged Carbon Steel, Stainless Steel types 303 and 316. Seat and seal materials available: Teflon, Buna-N and Neoprene (others available on request.)

The many combinations of body and seat seal materials allow handling of exceptionally wide range of media.

Other Outstanding Features

- Compact for ease of installation
- Positive leakproof shut-off
- **In-line maintenance** permits quick, easy inexpensive repairs
- Two-way flow allows application of pressure or vacuum to either side of valve
- Quarter turn operation — readily adaptable to remote control
- Visual determination of OPEN — CLOSED positions — No manual check needed
- Round flow through the valve — minimum pressure loss and turbulence
- "Wiper-action" of resilient seat against ball eliminates abrasive wear due to foreign materials in media . . . assures leak-proof seal . . . long operating life

* Pat. Pending

Write for full particulars

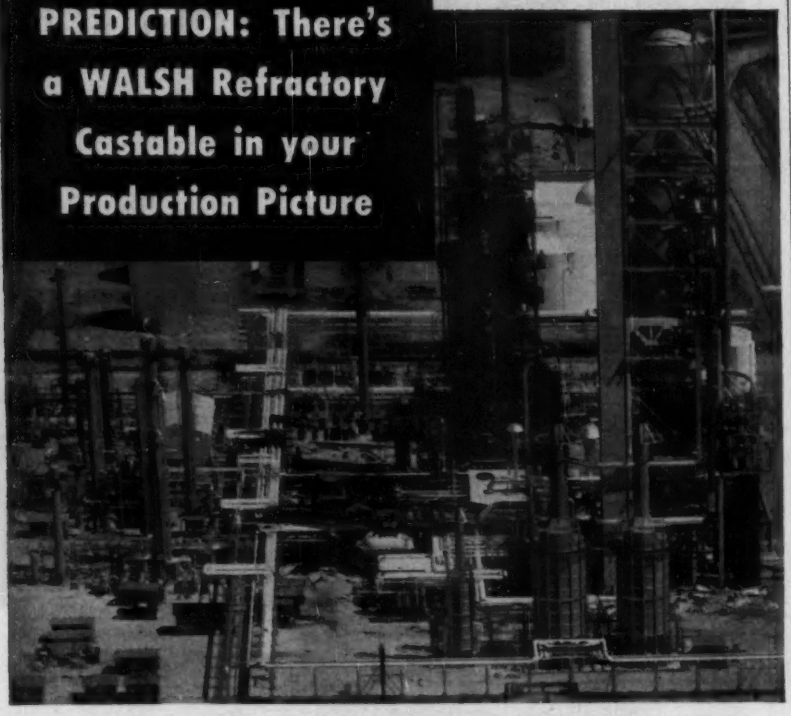
WORCESTER VALVE CO., Inc.

15 PARKER STREET WORCESTER, MASS.

Ball, Gate and Needle Valves

For more data on advertised products, use Readers' Service Cards, last page.

PREDICTION: There's a WALSH Refractory Castable in your Production Picture



Assurance Of New Highs In Performance At Lower Cost

Whether your refractory castable practice calls for a two-component lining or consideration of a "one shot" system later on—you'll find the right Walsh product for your purpose. Modern as tomorrow, every Walsh Castable offers absolute homogeneity—the result of production control methods that insure the perfect union of all ingredients for efficient service throughout a longer life. The whole money-saving story is available from your nearest Walsh representative. Or, write us direct, today.

WALSH EXTRA STRENGTH H & B CASTABLE (Service Type) For highly abrasion-resistant, monolithic, working linings in catalytic regenerators, reactors, and other refinery equipment.

WALSH LITE WATE INSULATING CASTABLE NO. 50. Features high bulk density while retaining a low K factor. Recommended for back-up use in two-component linings.

WALSH LITE WATE INSULATING CASTABLE NO. 70. Higher strength and a low K factor makes this insulating castable highly desirable for "one shot" linings.

All Walsh Castables are characterized by extreme "flowability", excellent nozzle compaction, lower rebound loss . . . plus greater strength, better bond . . . throughout the complete temperature range.

Send for New Illustrated Castable Bulletin

WALSH
REFRACTORIES CORPORATION
101 Ferry Street · St. Louis 7, Missouri
SPECIALISTS IN REFRACTORIES OF HIGH BULK DENSITY AND LOW POROSITY

Suppliers . . .

Sam Gurley, Jr., vice president of sales, Aluminum division, made the announcement. Waterman had been manager, extrusion sales, for Kaiser Aluminum and Chemical Sales, Inc., Chicago.

Waterman will have direct responsibility for the direction and coordination of product and industrial sales, and engineering service.

Prior to his Kaiser affiliation, Waterman served in various technical and sales capacities with Revere Copper and Brass, Inc. His last position with Revere was that of assistant sales manager for aluminum in the company's Midwestern division. Previously, he spent more than five years in the company's New England division as assistant sales manager for copper and brass, and as technical advisor to the division.

Waterman attended the University of Michigan and Illinois Institute of Technology, majoring in metallurgy, and received an M.S. degree in Business Administration from the University of Chicago.

CALUMET STEEL DIVISION of Borg-Warner Corp. has completed plans for a multi-million dollar expansion and improvement program at Chicago Heights, **H. J. Davis,** president of Calumet, announced recently.

The program, largest ever undertaken by the division, will be divided into two stages, the first of which will increase capacity by at least 40 percent. This phase is scheduled to be completed no later than December 31, 1959.

The second phase of the program, which contemplates the installation of electric furnaces and additional rolling and finishing facilities, is scheduled for completion by mid-1961.

FLORI-HOUSTON PIPE FABRICATION DIVISION of the Sparton Corp. has appointed **A. C. Armendariz** sales representative. He will use Mexico City as a base for operations. Educated in the United States, and a graduate of Purdue University, Armendariz has offices at Apartado Postal 80 BiS, Mexico, D. F.

FLUOR PRODUCTS CO., Whittier, Calif., has signed an exclusive agreement with Maschinenfabrik Hartmann A. G., Offenbach, Germany, to design, manufacture and sell the German firm's complete line of heavy duty industrial conveying systems, ash handling systems, dust removal and classifying systems.

In line with the agreement, Fluor has established a new division, Fluor-Hartmann, headed by **James Elizardi,** formerly vice president Mid-Continent sales area.

UNITED STATES RUBBER CO. has appointed **Dr. W. F. Tuley** to the new post of group manager of chemical development for the Naugatuck Chemical division. He formerly supervised rubber chemical and synthetic rubber research.

Dr. Tuley has B.S. and M.S. degrees in chemical engineering from Oregon State College. He obtained his Ph.D. degree from the University of Illinois. He joined the rubber company as a chemist in its general laboratories in 1928. In 1934 he transferred to the chemical division to work on rubber chemicals and has held several supervisory positions in the division's sales, production and research departments.

For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

UNITED STATES STEEL CORP. has announced the promotion of **Ray D. Morrison,** field representative at Charleston, W. Va., for the Oil Well Supply Division to district representative at that city. **C. H. Maynard,** manager of "Oilwell's" Eastern area made the announcement.

Morrison was employed by "Oilwell" in 1941 at the Charleston store. From 1942 to 1946 he served with the U. S. Army. He returned to the Charleston store and was appointed field representative at that location in 1950.

CRANE CO. has elected **George F. Burley** vice president for purchasing and traffic. He succeeds **Lucien W. Moore** who resigned because of ill health after 35 years of service.

Burley recently was director of purchases for Warwick Manufacturing Co., Chicago. His responsibilities there included direction of all traffic activities in addition to purchasing. Prior to that, he served as manager, raw materials purchasing, at Hotpoint, Inc., Chicago, and as director, transportation and supply, with Lustron Corp., Columbus, Ohio.

ORONITE CHEMICAL CO. has elected **Norman E. Hathaway** director and vice president-marketing it was announced recently by the **T. G. Hughes,** president of Oronite.

In his new job, Hathaway will direct all marketing of Oronite chemical products. Formerly Oronite's general sales manager, Hathaway succeeds **Milton L. Baker,** who retired.

Hathaway joined Oronite, a subsidiary of Standard Oil Co. of California, in 1954. Prior to this he was director, chemical and rubber division, business and defense services administration, Department of Commerce, in Washington, D. C. During World War II he served in the U. S. Navy submarine service.

Hathaway, a native of Corvallis, Ore., is a graduate of the University of Maryland, with a B.S. degree in chemical engineering.

UNIVERSAL OIL PRODUCTS CO. has moved its Chicago office to Suite 2061 of the McCormick Building, 332 South Michigan Ave.

The company, which has had its general headquarters in Des Plaines, Ill., since 1952, had maintained offices at 310 S. Michigan Ave. for more than 30 years. It was the first company to move into the then new skyscraper, and at one time was the building's largest tenant, occupying several floors.

TRACERLAB, INC., has announced the association of **Robert S. Schmidt** with the firm as district sales manager responsible for sales in nine western states, Alaska and Hawaii.

Prior to joining Tracerlab, Schmidt was assistant sales manager for the Sequoia Wire Co., Redwood City, Calif. He was a sales engineer with the west coast division of the Minneapolis-Honeywell Co. for several years and prior to that was marketing survey coordinator with the Pacific Tractor and Implement Co. He holds a B.S. degree from the University of California.

Petroleum Refiner Classified Ads

Petroleum Refiner New Classified Rates

RATES: Regular Classified (undisplayed) **set** in this type: 20 cents per word. Minimum charge, $4. Blind box address in our care counts six words. Replies forwarded without charge. **Display Classified ads,** set in suitably larger type with ruled border, $12.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

HELP WANTED

CHEMICAL ENGINEER

Excellent opportunity with a West Coast Independent Oil Company (San Joaquin Valley). Refinery Experience, Process Design and Operation essential. Must have Engineering Degree. Salary Commensurate with ability and experience. Reply outlining personal history, photograph and work background. Box 277-R, PETROLEUM REFINER, Houston, Texas.

CHEMICAL and MECHANICAL ENGINEERS

A large and expanding international petroleum company has openings for several Chemical and Mechanical Engineers with outstanding ability. This is a challenging opportunity to share the responsibility of coordinating international refining operations. Excellent advancement opportunities for applicants with a minimum of 3 years petroleum or chemical industry experience. Immediate assignment to our Far East refineries or to our White Plains Headquarters with an eventual overseas assignment. Salary commensurate with experience, liberal annuity, insurance, hospitalization and savings plans. Will pay moving and transportation expense. Please send resume to:

DENNIS V. WARD
STANDARD-VACUUM OIL COMPANY
P. O. BOX 1000
WHITE PLAINS, N. Y.

Send for your **FREE** copy of the **New Petroleum Books Catalog** containing descriptions of many books pertaining to the Petroleum Industry. Send your request to **Book Department, Gulf Publishing Co., P. O. Box 2608, Houston 1, Texas.**

HELP WANTED

CHEMIST-PROJECT LEADER

General experience required in some phase of petrochemical processing, hydrocarbon conversions, polymerization, or separation of products.

This is a very challenging development position designed to produce improved products and processes and to provide new raw materials leading to new product programs.

Company is progressive and a leader in its field with plans to expand and diversify. Research and development laboratories located in Chicago. In first letter state training, experience, references and salary requirements. Reply to Vice President, Director of New Products, Box 282-R, PETROLEUM REFINER, Houston, Texas.

MECHANICAL DEPARTMENT SUPERINTENDENT returning from foreign service. 14 years experience in refining covering maintenance and construction, instruments and operations. Desire a position with petroleum or Petrochemical company in States. Box 279-R, PETROLEUM REFINER, Houston, Texas.

CHIEF PROCESS & DESIGN ENGINEER
for
Gas Processing and Oil Refinery Operations

Canadians Note—Unusual opportunity for supervisory engineer with young, growing, integrated Canadian oil company. Should have 10 years experience in plant process and design engineering.

Write: Box No. 281-R,
PETROLEUM REFINER
Houston, Texas

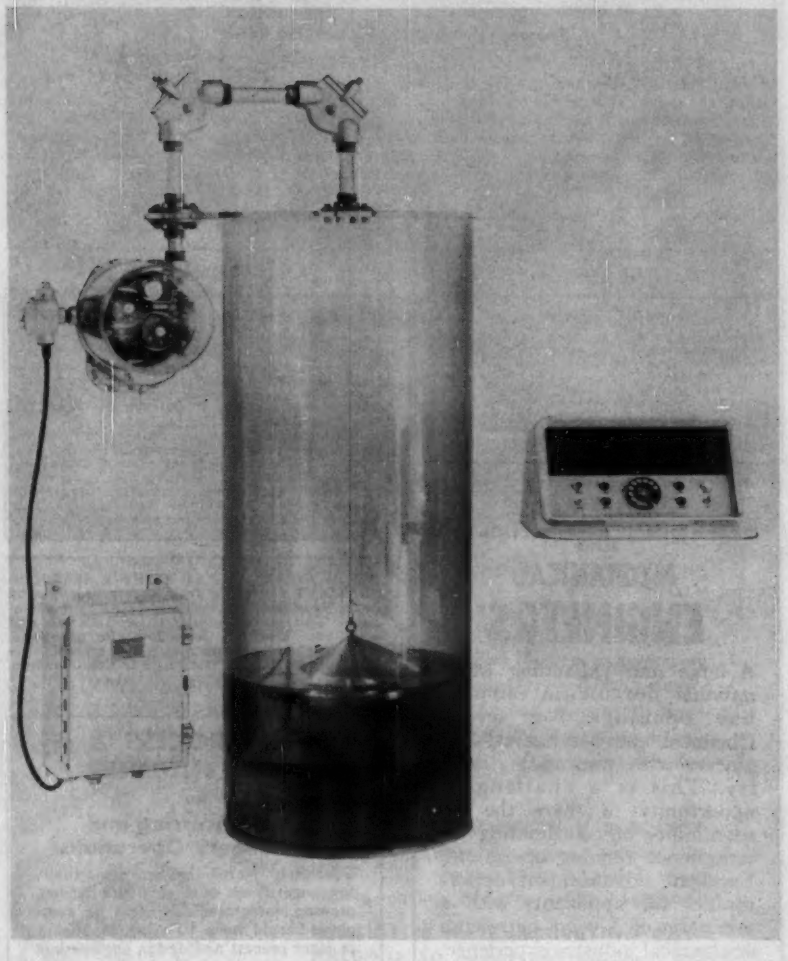
WANTED TO BUY

SMOKE STACK, APPROXIMATELY 42" DIAMETER, 100 FEET LONG, ¼" STEEL. INDEPENDENT STAVE COMPANY, LEBANON, MO.

REFINER
Classified Ads Bring
RESULTS

What's New in Equipment . . .

. . . and Manufacturers Literature



Dial System Tells Tank Levels

In the eastern office of a large oil company, someone wants to know the amount of oil stored in a certain tank on a Gulf Coast tank farm.

With the benefit of the TI Data Gage, he dials the number of the oil storage tank on a console similar to a telephone dial and in a matter of seconds, flashed on the console, is the depth of liquid to an accuracy of one-sixteenth of an inch.

This new transistorized electronic system for measuring the level of liquid in any of 100 remotely located storage tanks, is already in operation on three tank farms.

The operator dials the particular tank he wants to monitor and is connected immediately through the field selector unit to the liquid gage on that specific tank. A dynamic mechanical surface finder is activated and when the bottom of the float breaks the surface tension of the liquid in the tank, the data is telemetered to the receiver console where it appears in lighted numbers. Texas Instruments, Inc.

Circle E1—green card, last page

High Speed Diaphragm Pump Described In Bulletin

A two color, four page bulletin describing the new McCannameter diaphragm pump has just been released.

This bulletin describes in detail the pump from the schematic drawing to its high speed (up to 900 strokes per minute) versatility in precise ratio control. Also shown are some of the possible multiple feed arrangements. Hills-McCanna Co.

Circle E2—green card, last page

Ceramic Tool Outperforms Conventional Tool Speeds

A new ceramic cutting tool, seven times better than its predecessor, was recently shown.

The tool is a newly developed aluminum oxide composition. In laboratory controlled tests and limitel field tests, the new ceramic tool outlasted and outperformed its forerunner.

In one production operation, 13-inch diameter steel mill rolls of chilled cast iron were to be remachined. Hardness of the roll was R.60. Because of the large diameter of the roll, the machining speed could not be reduced below 45 feet per minute on the lathe to be used. At this speed, conventional tools failed in a matter of seconds. After breaking twelve tools, the new ceramic tool was tried.

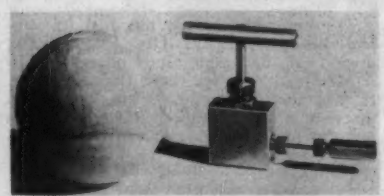
The ceramic tool cleaned up the area gouged by the broken tools and went on to make the first pass at 66 fpm, or about three times normal turning time. The depth of cut was .060 inch and the feed, .008 inch per revolution. The new tool ran two hours and five minutes. The taper in the 15-inch length of the roll was only .001 inch and the surface shone as though polished. Norton Co.

Circle E3—green card, last page

Comparative Price Data On Seamless Pipe and Tubing

Engineers, buyers, estimators and others responsible for the specification and procurement of seamless stainless pipe and tubing will be interested in the comparative price data furnished on Technical Data Card 188. This card furnishes the analysis details and comparative price ratios of 33 seamless stainless grades using Type 304 (18-8) as a base. The Tubular Products Division of The Babcock & Wilcox Co.

Circle E4—green card, last page



Midget Pressure Valve Can Fit Inside A Tennis Ball

A new high pressure valve, so tiny it can fit inside a tennis ball and dwarfs all former so-called midget valves, has now been developed.

With a body slightly larger than an ordinary postage stamp, this tiny valve is designed for one-sixteenth inch tubing to handle up to 15,000 psi. The stem is non-rotating that never turns and always seats securely. Available in stainless steel, Monel or Hastalloy, it is adaptable for

—Photo courtesy Standard Oil Company (N.J.)

How soon will you be forced to recover stack BTUs?

The constant rise in cost of fuels means simply this: it is becoming more and more uneconomical to dissipate so much of your fuel up the stack. Particularly, since so much of it – nearly one third – can be put *back to work.*

For with modern process equipment, which includes a Ljungstrom Air Preheater, you can save as much as 30% of the fuel burned! That's a *saving of 1½ barrels in every five.*

Heat recovery can also be used to generate higher flame temperatures and increase heat-transfer rates. This makes it possible to *raise through-put as much as 25%.*

LJUNGSTROMS ARE WRITTEN OFF FAST

Ljungstrom has many other advantages. More complete combustion greatly reduces slagging . . . makes possible use of lower grade fuels . . . helps raise product quality. With these added benefits it's not difficult to see why a Ljungstrom is often paid out in less than a year.

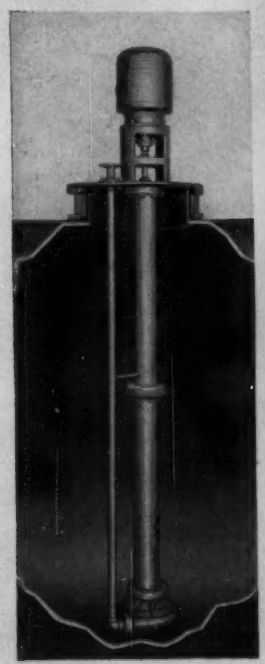
For more complete data on what Ljungstrom Air Preheater can do to help you save on production costs . . . and for an analysis of the heat recovery benefits obtainable in fuel burning equipment – call or write the Air Preheater Corporation.

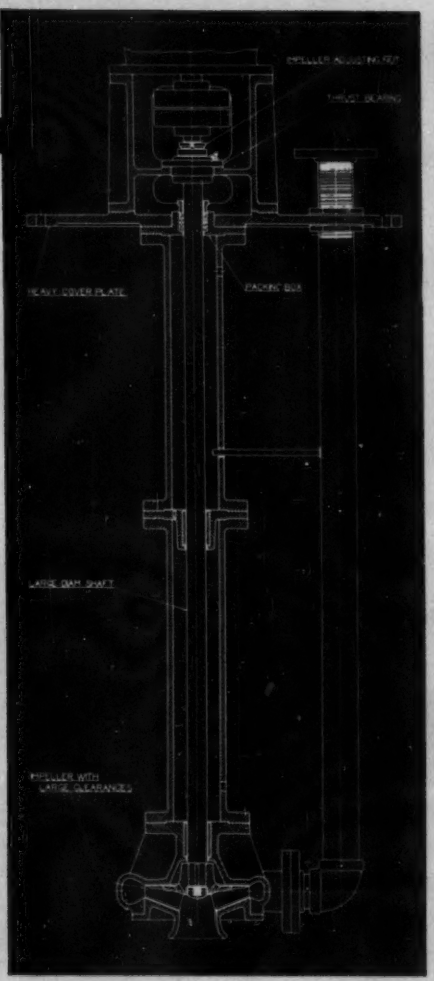
Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

(Right) Structural details of Lawrence Vertical Chemical Pump.
(Below) Vertical Chemical Pump mounted inside of tank.



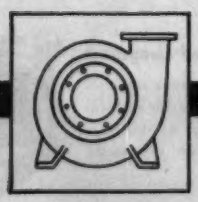


VERTICAL CHEMICAL PUMPS

Difficult chemical pumping problems—handling hot concentrated acids, corrosive alkalies, molten salts, molten sulphur, volatile semi-fluids, etc.—have been a LAWRENCE specialty for over 80 years.

To meet the demands of this rigorous service, LAWRENCE Vertical Chemical Pumps are made of metals or alloys carefully chosen to give the best protection against the corrosive and abrasive action of the liquid pumped, as well as structural strength and long wear. Other design features (depending on the circumstances) include liquid seals for high vacuum, the elimination of packing, mounting bearings above the level of the liquid pumped to prevent contact, and many more refinements that contribute vitally to efficient, trouble-free operation.

If you have a particularly difficult chemical pumping problem, write us the pertinent details.



LAWRENCE PUMPS INC.

371 MARKET STREET, LAWRENCE, MASS.

New Equipment . . .

standard compression, socket weld and I P S connections.

The new high pressure midget valve, because of its extremely tiny design, establishes a new high in safety while conserving space and effecting economy. The capacity of the system, with a minimum of hold-up is ideal for gage lines, instrument, sampling and catalytic injection systems. High Pressure Equipment Co.

Circle E5—green card, last page

Simple Zipper Jacket Encases Wire or Pipe

Groups of wires, tubes, pipes and hoses can be protected by Zippertubing from abrasion, corrosion, critical environmental conditions and excessive wear by the use of this plastic jacket with its zipper-type closure. Not only can the encased hoses or pipes be clearly and simply identified but installation is quick and easy with any zipper-operated item.

The zipper pull-tab used to close Zippertubing is detachable and may be "unzipped" and re-used where required or permanently sealed with a sealer provided by the manufacturer. When sealed, the seam will withstand a linear strength test of 45 psi. Sizes range from three-eighths inch ID and larger in increments of one-eighth inch. The tubing is available in nine different colors and in continuous lengths from 20 to 1000 feet. Zippertubing Co.

Circle E6—green card, last page

Globe Type Needle Valve For Gage or Meter Service

An entirely new globe type needle valve, for use as a gage or for metering service in gas, oil, water lines, or other similar uses, is now announced.

It has been developed to provide a high-quality, economical valve for applications where space is a factor and where operating areas are close. It is exceptional for use in meter boxes, pressure gage controls, laboratories, as sampling valves, and in any application where a high-pressure, accurately controlled, perfect shut-off needle valve is required.

Designated TYPE N-28, the new valve features a one-piece solid forged carbon

DU PONT *Petroleum Chemicals* NEWS

Number 83 in a Series of Bulletins for the Petroleum Industry

JANUARY 1958

New DuPont facilities add efficiency in supplying tetraethyl lead

Highlights in the history of tetraethyl lead development

1920
DuPont scientists take active part in new investigations of the cause of knock in automobile engines . . . and how to prevent it.

1922
DuPont begins construction of world's first tetraethyl lead plant at Carney's Point, N. J.

1924
DuPont manufactures first commercial quantity of tetraethyl lead by chloride process . . . assuming responsibility of producing total tetraethyl lead requirement of the entire oil industry.

1948
DuPont begins to supply tetraethyl lead direct to refiners.

1953
DuPont adds new TEL unit at Chambers Works . . . makes substantial increase in manufacturing capacity.

1957
New DuPont tetraethyl lead manufacturing plant goes on stream at Antioch, California . . . further increasing capacity.

1957
New DuPont TEL terminal to serve Gulf Coast and Midwest refiners goes into operation at Beaumont, Texas.

1957
First tank ship to carry tetraethyl lead in bulk, *MV Petrochem*, starts regular voyages between Carney's Point and Beaumont.

The oil industry has increased its efficiency continually over the years, thereby producing better and better products for the motoring public. As a result, the industry is today making available more power per dollar than ever before.

A factor in this accomplishment is the wide use of tetraethyl lead, the most economical method of increasing octane numbers.

To keep this economy product readily available we, at DuPont, have continued to increase efficiency, toward the end of constantly improving our TEL production and distribution facilities. For example . . .

THIS MODERN TANK SHIP, MV Petrochem, is the first and only ship of its kind. It was specially designed and built to transport DuPont tetraethyl lead in bulk to the Gulf Coast refining area.

Increasing our efficiency with modern, new facilities such as the MV Petrochem tank ship and the new TEL manufacturing plant at Antioch, California, helps us to offset the steadily rising costs of equipment, raw materials and labor.

Economy through service

Many of the services offered by the DuPont Petroleum Chemicals Division are aimed at helping you achieve desired octane levels at the lowest possible cost. The economic studies offered by our refining technologists are

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

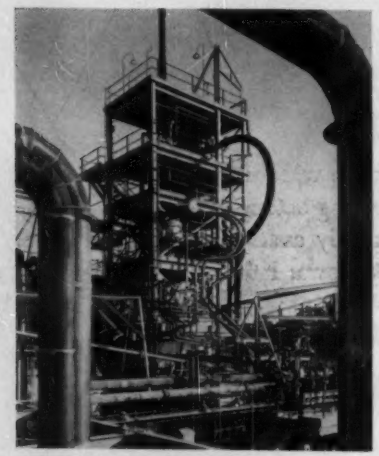
DUPONT *Petroleum Chemicals* NEWS

CONTINUED *TEL Economies*

an example of this type of service. And our operations group is always prepared to help you with your additives handling problems. Their suggestions frequently lead to new methods or equipment which can reduce your treating costs.

Research, too

The fruits of basic research are among the most dynamic factors in our economic progress. To enable refiners to benefit directly from our basic research, the DuPont Petroleum Laboratory is constantly investigating



THIS NEW DuPont tetraethyl lead manufacturing plant at Antioch, California, incorporates the most modern TEL manufacturing facilities in the world. It makes possible fast, short-distance shipments of California-made TEL to all West Coast refineries.

combustion chamber reactions. And we make the results of this work readily available to the refining industry through technical papers delivered at the various industry meetings.

FOA-2 Cleans Residual Fuel Systems

Field tests repeatedly demonstrate that the *solubilizing* action of FOA-2 tends to break up agglomeration of sludge, thus permitting individual particles to be held in suspension by the dispersing property of the additive.

See the
"DuPont Show of the Month"
on CBS

NEW POSITIONS FOR TWO PETROLEUM CHEMICALS MEN

WESLEY T. DORSHEIMER has been transferred to Wilmington as assistant sales promotion manager of the Petroleum Chemicals Division.

He was formerly assistant manager of the Petroleum Chemicals Division's Eastern Region with headquarters in New York.

WESLEY T. DORSHEIMER

Taking Mr. Dorsheimer's place as assistant manager of the Division's Eastern Region is R. Carter W. Jones. Mr. Jones was formerly sales-service manager in the Wilmington office.

Mr. Jones joined the DuPont Company in 1936 as a chemist at the Jackson Laboratory. In 1939 he was made manager of the DuPont Tetraethyl Lead Laboratory.

From 1941 to 1950 he was engaged in research work at the DuPont Petroleum Laboratory and worked with the Technical Section of the Petroleum Chemicals Division. He was then transferred to the Division's Sales Promotion Group and made its manager.

Mr. Jones is a graduate of the University of Virginia with a B.S. degree in chemistry. He is a member of Alpha Chi Sigma, professional chemical fraternity, Sales Promotion Executives' Association and the Sales Executives' Club of Wilmington.

R. CARTER W. JONES

Special DuPont services of interest to management men

Top management men in oil companies have many interests in common with our own administrators. Both can benefit from a general exchange of information.

The Petroleum Chemicals Division has a special management services program covering topics of particular interest to oil industry executives. Based on DuPont's own administrative methods, it includes a cost reduction program, a chartroom presentation on how DuPont measures its performance, discussion-leading techniques, and oil industry public relations aids.

Any of our representatives will gladly give you more information.

SALES OFFICES

Chicago 3—8 So. Michigan Ave. . . . RAndolph 6-8630
Cleveland 15—25 Prospect Ave. . . . SUperior 1-1363
Denver 2—Petroleum Club Building, 16th & Broadway . . . . . AComa 2-2347
Houston 2—705 Bank of Commerce Bldg. . . . . CApitol 5-1151
Los Angeles 17—612 So. Flower St. . MAdison 5-1691
New York 20—1270 Ave. of the Americas . . . . . COlumbus 5-2342
Philadelphia 2—3 Penn Center Plaza . . LOcust 8-3531
Pittsburgh 22—1 Gateway Center . . . ATlantic 1-2933
San Francisco 4—111 Sutter St. . . . . EXbrook 2-6230
Seattle 3—4003 Aurora Ave. . . . . MElrose 6977
Tulsa 1—1811 So. Baltimore Ave. . . . . LUther 5-5578
In Canada—DuPont Company of Canada (1956) Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12**—Ontario . . . . . HUdson 1-6461
In Other Countries—Organic Chemicals Department, Export Division, 7447 Nemours Bldg., Wilmington 98, Del., OLympia 4-5121, Ext. 2962.

DU PONT
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Better Things for Better Living
. . . through Chemistry

DuPont Tetraethyl Lead and other Petroleum Additives

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

A-5871

Printed in U. S. A.

steel body with a twelve-fourteenths chromium heat-treated stainless steel stem with Teflon packing. Short, compact, and precision machined, this valve is available in sizes of ⅛ inch, ¼ inch, ⅜ inch, and ½ inch. It has a maximum working pressure of 10,000 pounds p.s.i. at 70 F., and a maximum operating temperature of 500 F. Kerotest Manufacturing Co.

Circle E7—green card, last page

Inert Plastic Resists Chemical Attack

Polytetrafluoroethylene is the most chemically inert plastic material which is so far commercially available. It can be used over a temperature range of —100 C to 250 C. Within these temperature limits, it is attacked only by fluorine and molten alkali metals.

"Kingerflon" is non-adhesive and is non-wetting. It is also unaffected by surface condensation. It has excellent electrical properties. It is smooth and waxy to the touch and in appearance is generally white, but when viewed in thin sections, becomes translucent.

The material has been successfully formed into various gaskets, joints, diaphragms, packings, chemical seals and in the form of O-rings. A company publication describes in detail all of these applications. Richard Klinger, Ltd.

Circle E8—green card, last page

Basic Text on Butadiene Covers 150 Reactions

A 52-page technical manual on butadiene which is believed to be the most comprehensive manual yet written on this chemical which is a major raw material for synthetic rubber, has just been published.

The basic text was written for research chemists and others working on new products and processes. It is designed to encourage new chemical applications for this raw material which is already one of the few billion-pound per year chemicals.

The manual contains specifications, physical and chemical properties, covers 150 chemical reactions, extensive indices on fields of end uses, reactants and reaction products and information on samples for experimentation. Its bibliography contains more than 300 references.

There are four main sections. Under physical properties there is an extensive list of properties taken from all available literature on the chemical. The material is presented in both tables and charts. The characteristics of butadiene, a separate section, are discussed in three major areas, dimerization, peroxide formation and butadiene's relative reactivity with various other monomers. Texas U. S. Chemical Co.

Circle E9—green card, last page

Aluminum Gate Valves Handle Problem Fluids

After approximately two and a half years of development work and testing, accompanied by limited production for special purposes, gate valves of aluminum alloy are now being offered for general application.

The aluminum alloy gate valves currently available range from one-half inch through 24 inch sizes and include types for every requirement where aluminum piping systems are now being used or planned.

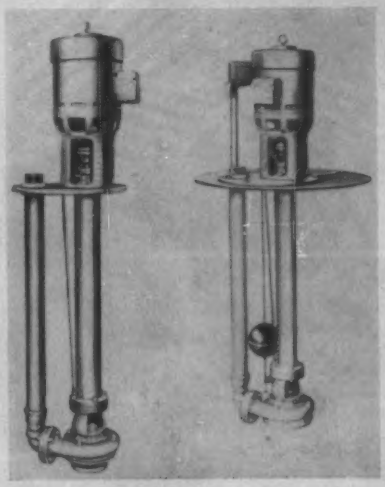
These new aluminum alloy valves incorporate the principle of fully revolving

New Equipment . . .

double disc parallel seat gate valve operation.

Very sizeable savings are possible, particularly in large valves, compared with valves of other metals suitable for the handling of problem gases and fluids. These savings not only accrue in the shipping, handling and installation of the lighter weight aluminum alloy valves, but also pertain to their initial cost due to basic weight and material cost factors in manufacture. Darling Valve & Manufacturing Co.

Circle E10—green card, last page



Heavy Duty Process Pump Has Standardized Parts

A new and complete line of heavy duty vertical centrifugal pumps for sump and process service has now been introduced. These single and duplex units, both wet and dry type, have capacities to 1080 GPM with heads to 290 feet for pit depths up to 20 feet.

Basic design of the sump pumps provides users with custom built pumps through novel usage of standardized parts. This means that the pumping unit may be adapted in the field for changed pit depths or pump ratings simply by installing new and standardized parts. Vapor proof construction can be supplied on all units with all possible points of leakage of vapor or fumes sealed including shaft, bearing housing, cover plate, discharge pipe, grease pipes; float rod and pit covers are drilled on periphery for gasketed joints. In addition, special construction and materials, including 303 stainless steel shaft, carbon, rubber or carbon filled Teflon bearings, stainless steel or ceramic floats, stainless steel float rods, permit these units to handle various types of liquids. Goulds Pumps, Inc.

Circle E11—green card, last page

Powdered vs. Liquid Acid Discussed In Report

The properties and uses of Drycid, the recently introduced powdered acid scale and rust remover, are described in a service report just published.

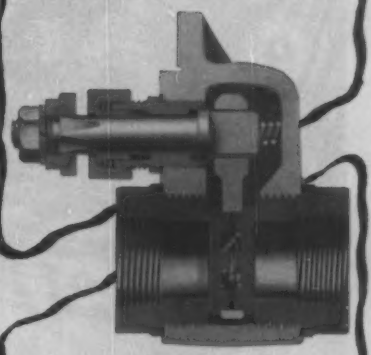
The service report points out the convenience inherent in shipping, storing, and using a powdered rather than liquid acid;

FULL-FLOW

Okadee

VALVES

NON-LUBRICATED



POSITIVE

STOP

FOR

- Steam
- Air
- Ammonia
- CO_2
- Gasoline
- Propane
- Styrene
- Butadiene
- Lube Oils
- Jet Fuels

Available in Stainless Steel or Steel, Chemically Nickel Coated

You can select Okadee Valves for flow by pipe size—and get full-flow and positive shut-off with virtually any liquids and gases.

Quick-opening, metal-to-metal disc valves and seats require no lubrication—virtually no maintenance for hundreds of thousands of operations . . . Real valve *performance* and *service*.

FACTS AND FIGURES

. . . on Okadee Valves will be sent promptly on request. Sizes ½" to 8"; A.S.A. dimensions; screwed or flanged. Valve seats and discs Stellite or stainless steel; your choice of operators.

• Write for Bulletin CP6

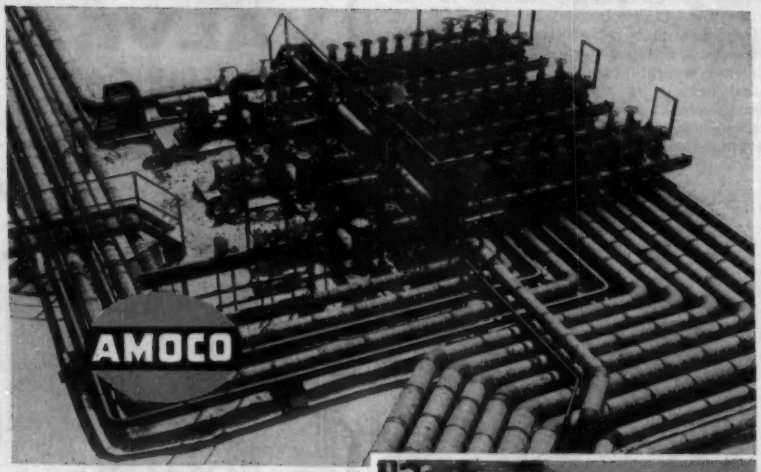
Okadee COMPANY

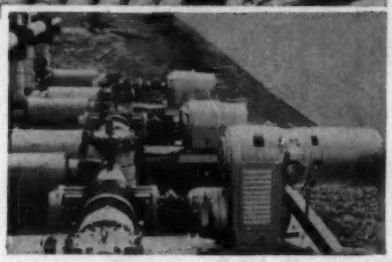
332 SOUTH MICHIGAN AVENUE

CHICAGO 4, ILLINOIS

AMERICAN OIL COMPANY equips two east coast Asphalt terminals with

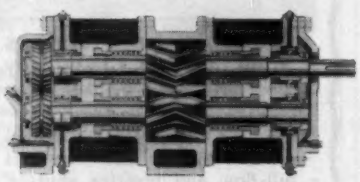
Sier-Bath GEAREX® PUMPS



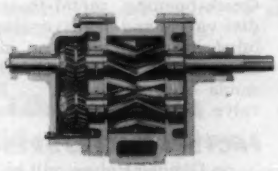


• Above is a typical asphalt terminal manifold using three "Gearex" Pumps. Each pump is designed to deliver 350 gpm. of asphalt with 600-3,000 SSU at 300 to 130° F., discharging at 50 psig. with a 16" Hg. maximum suction lift. The big feature is the external gear and bearing design which protects vital pump parts against damage when handling hot asphalts, crudes, cutbacks and other viscous, non-lubricating materials.

***Sier-Bath* "Gearex" Pumps**



EXTERNAL GEAR & BEARING TYPE
for non-lubricating liquids



INTERNAL GEAR & BEARING TYPE
for lubricating liquids

Sier-Bath "Gearex" Pumps provide positive displacement, pulseless flow . . . quiet, vibrationless operation. Direct-connected up to 1800 RPM, they require no reduction gears. For sustained high volumetric efficiency and long life there is no rotor-to-rotor or rotor-to-casing contact. Low pressure on stuffing boxes provides easy servicing.

Horizontal or vertical models to handle 32 to 500,000 SSU, 1 to 550 GPM at 250 PSI for viscous liquids, 50 PSI for water. Corrosion-resistant alloys, steam-jacketed bodies, water-cooled bearings, other adaptations to meet individual needs. Call your local Sier-Bath Pump Representative . . . send for Bulletin G-2. *Sier-Bath Gear & Pump Co., Inc., 9261 Hudson Blvd., North Bergen, N. J.*

Sier-Bath ROTARY PUMPS

Screw Pumps **Gearex® Pumps** **Hydrex® Pumps**

50th Anniversary **Mfrs. of Precision Gears, Rotary Pumps, Flexible Gear Couplings** **Member A.G.M.A.**

New Equipment . . .

the lack of bothersome acid fumes; and the material's increased safety on various metals. One of the major advantages discussed is Drycid's greater safety when used to descale systems containing dissimilar metals.

Recommended solution concentrations and application methods are given in the service report. Oakite Products, Inc.

Circle E12—green card, last page

Wire Stripper Has Quick Notch Setting Device

A new design wire stripper has just been announced. For the professional user, this improved tool which is only five inches long features a thumb-operated gage and strips all commonly used insulated wire from 14 to 24 gage without nicking or cutting. Even the larger sizes of wire can be handled with ease. Specially hardened edges cut easily.

A big advantage of this tool is that all settings can be made quickly. The method is simply to turn the star gage to the desired notch opening size, notch, and strip. Plastic grips lessen fatigue and increase user comfort. Streamlined design permits work in tight places. Proto Tool Co.

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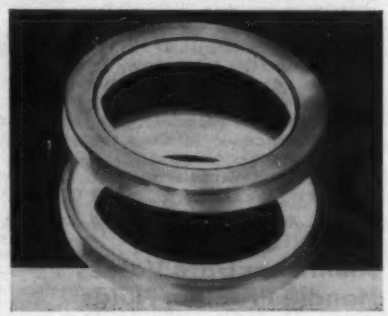
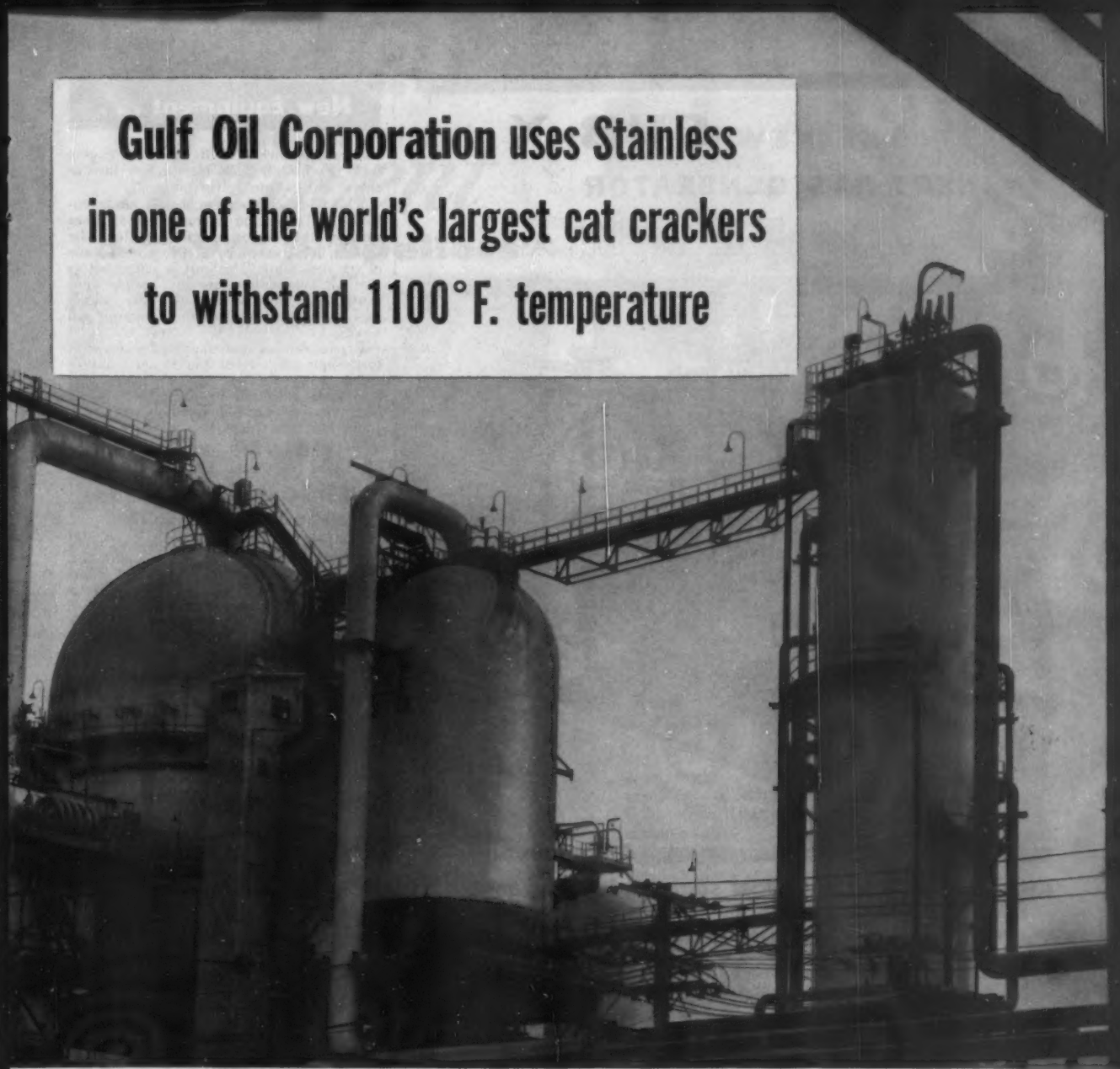


Solvents Have No Effect On Teflon, Positive Seals

New Chempac Teflon Clipper Seals, which will enable industrial plants to obtain positive sealing in the presence of and in contact with active solvents and corrosives, are now being placed on the market.

These new seals have successfully contained oils with varying aniline points that are destructive to many compounds. They have also proved effective against

Gulf Oil Corporation uses Stainless in one of the world's largest cat crackers to withstand 1100°F. temperature



One of the largest catalytic crackers in the world, at Gulf Oil Corporation's Philadelphia refinery. Regenerator at left produces about 64,000 barrels per day.

IN ITS PHILADELPHIA REFINERY, Gulf operates one of the world's largest catalytic cracking units. It produces high octane gasoline, heating oils, fuel gas, gas oil, propane-propylene and butane-butylene. Capacity is about 64,000 barrels per day. 9 million pounds of catalyst circulate each hour, and the unit consumes nearly 400,000 pounds of steam per hour.

The top of the spherical regenerator is shingled with 14-gage Stainless Steel strip. Temperature reaches about 1100° F. in the burning atmosphere, and the Stainless Steel shingles resist erosion caused by the pressure circulation of the catalyst, which has the consistency of talcum powder. Carbon steel shingles would deteriorate and fail rapidly. Bottom section and cone of the fractionating tower (right) are lined with Stainless Steel to withstand corrosion at high (700° F.) temperature.

Stainless Steel gives you the most for your money when it is designed *into* equipment, right from the start. So think of Stainless Steel when you design. Think of *USS* Stainless when you buy.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALABAMA
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
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USS STAINLESS STEEL

SHEETS • STRIP • PLATES
BARS • BILLETS

USS

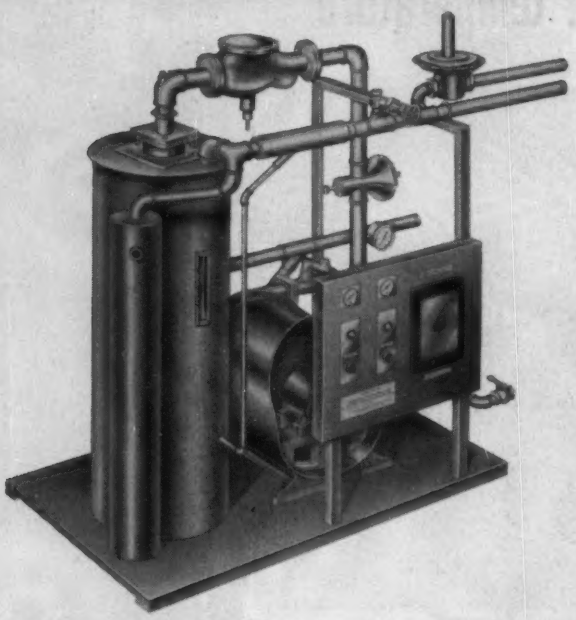
PIPE • TUBES • WIRE
SPECIAL SECTIONS

UNITED STATES STEEL

THE NEW **SUB-X**

INERT GAS GENERATOR

by THERMAL



A compact...

economical source of inert gases

THERMAL'S SUB-X generator offers unsurpassed operating economy and efficiency. Its unique design utilizes submerged exhaust of combustion products and permits the use of river water or other low-cost water supply as coolant.

The SUB-X generator is built around the THERMAL burner which can be fired with gas or distillate oil. Because of the burner's high heat release characteristics, the SUB-X generator eliminates refractory and reduces maintenance costs. Each unit is supplied as a complete package with all control and safety equipment. Standard models are available in capacities up to 35,000 SCFH of inert gas. Larger capacity units can be designed to your specifications.

WRITE FOR BULLETIN #114

OTHER THERMAL PRODUCTS & SERVICES
Gas, Oil, Combination Burners • Heat Exchangers • Submerged Combustion • Air Heaters • Combustion and Heat Transfer Engineering

THERMAL

Thermal Research & Engineering Corp.

CONSHOHOCKEN • PENNSYLVANIA

REPRESENTATIVES IN PRINCIPAL CITIES

New Equipment . . .

such widely diverse fluids as rocket engine fuel, perchlorethylene, destructive insecticides, and various refrigerants.

The body of the new seal is made entirely of Teflon and is encased in stainless steel or other corrosion resistant alloy. The seal lip is actuated by a spring also made of stainless alloy. The unit is assembled so that all components are in absolute concentricity. This precise assembly allows maximum sealability with minimum lip wear.

Recommended shaft finishes for use with these seals range from four to eight microinches (Superfinish). Shaft diameters: Springless as small as one-eighth of an inch; Spring Loaded one-half inch up. Johns-Manville Corp.

Circle E14—green card, last page

Sulfate Determinations In Less Than Half An Hour

Certified-Reagent Grade Barium Chloranilate, prepared in cooperation with the research department of a major oil company, is now manufactured specifically to expedite sulfate determinations.

Gone are the 24-hour gravimetric procedures which required precipitates to stand overnight; the reagent permits complete sulfate determinations in less than a half hour.

The stable brown-purple powder is used directly with the sample containing sulfate in a buffered pH 4.0 solution. The reaction yields barium sulfate and acid-chloranilate ion, the amount of acid-chloranilate liberated being directly proportional to the sulfate ion. Fisher Scientific Co.

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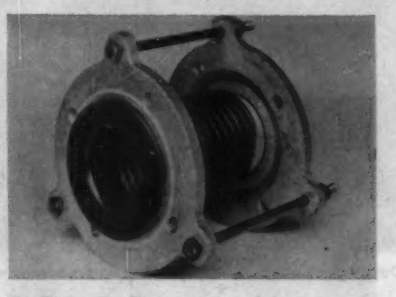


Teflon Bellows Resist Corrosion And Temperature

A complete line of Teflon bellows having twice the burst strength and 20 times or more the flex life of conventional bellows machined from Teflon cylinders has been announced. This outstanding performance can be attributed to their being molded of a patented, high density virgin Teflon compound rather than machined of conventional Teflon.

Fluoroflex-T Molded Bellows cover both low and medium pressure service. Dynamic working pressures as high as 120 psi, full vacuum service, bending deflection up to 70 degrees and axial movement to 2 inches or greater are just a few of the extraordinary characteristics of this new line.

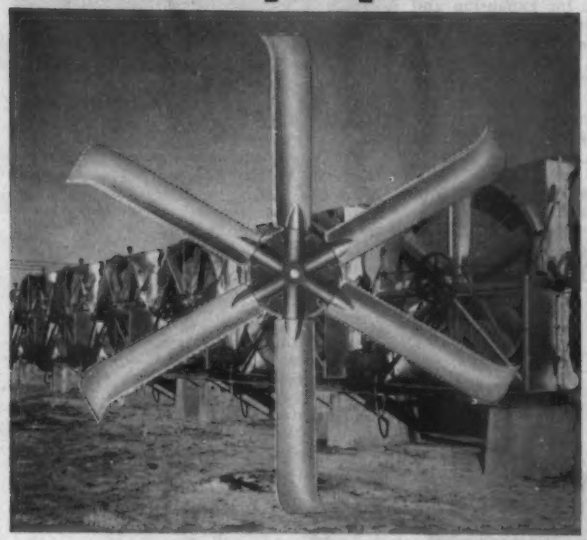
The molding process maintains the linear orientation throughout the bellows convolutions, thereby providing optimum tensile strength and fatigue life. The full

new adjustable pitch

"macheta" airfoil

Aerovent

54"-96" propellers



now available in

'T-ALLOY'

Acclaimed as *industry's most efficient air-moving* surface, Aerovent "Macheta" Airfoil Propellers are leading the way in cooling tower and heat exchanger fan design and engineering.

Latest innovation is the use of "T-ALLOY" for extra strength and additional corrosion resistance in especially rugged applications. Inherently a high-strength alloy, "T" provides better resistance to shock and vibration. This, plus *individual blade balancing* for complete interchangeability of all units and *universal pitch markings* to simplify accurate field setting, is your assurance of dependable, lasting performance in any installation.

STANDARD CONSTRUCTION ALUMINUM-ALLOY BLADES FURNISHED FOR ALL NORMAL-DUTY REQUIREMENTS

CAST ALUMINUM HUBS for light weight and ease of handling feature bolted construction for fast, easy assembly.

"POSITIVE-LOCKING" Pitch Adjustment is accomplished by keyways which hold peripheral-keyed blade shanks.

Write for free bulletin 500

Aerovent FAN COMPANY, INC.

LARGE PROPELLER DIVISION

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Main Office and Factory
PIQUA, OHIO

For Expanding Heat Exchanger Tubes

NEW WILSON Torq-Air-Matic

First and only air-driven tube expander drive that accurately controls tube expansion by directly measuring torque output at the mandrel

Only the Wilson Torq-Air-Matic offers all these features: air driven, automatic trip-off, completely integrated, non-electrical, non-frictional, calibrated in ft lbs torque, lightweight, simply adjusted.

Send for your copy of Wilson Bulletin 55.

Wilson Heavy-Duty Air Driven Cleaners

offer quick way to clean fouled heat exchanger tubes

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easy to use, does fast job, a fine, reasonably priced tool

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WILSON

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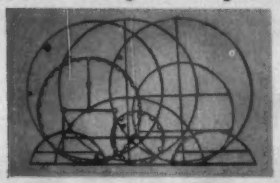
TUBE CLEANERS • TUBE EXPANDERS

GASKETS
For Every Purpose



HEAT EXCHANGER GASKETS

Made in any size or shape needed in double jacket type. Also cut from solid metal or sheet packing. Write for Bulletin 564.

CORRUGATED METAL GASKETS

Plain or jacketed type. Made of ingot iron, aluminum, stainless steel, copper, brass, nickel and monel in all sizes and shapes. Write for Bulletin 565.

PROMPT DELIVERIES

CHICAGO-WILCOX MFG. CO.

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THE BERGMAN
Safty-Spanner
a helper you can trust
MADE OF THE TOUGHEST ALUMINUM-MAGNESIUM ALLOY
WILL NOT
DAMAGE VALVES
MAKE SPARKS
MAKE BURRS
SLIP OFF

18 INCH
WEIGHS ONLY
2 LB.-13 OZ.
Developed by the men who use them daily!
The Bergman SAFTY-SPANNER CO.
927 BUTLER ST., TOLEDO 5, OHIO

New Equipment . . .

radius to the internal as well as external convolution distributes the stress uniformly around each convolution. A truly flexible bellows with unequalled service durability is the result.

This entirely new concept for the fabrication of bellows provides unparalleled flex life to compensate for expansion and contraction, misalignment and vibration in all piping systems, pumps, reaction vessels, valves, towers, storage tanks and many other applications where corrosion combined with high temperatures is a problem. Resistoflex Corp.

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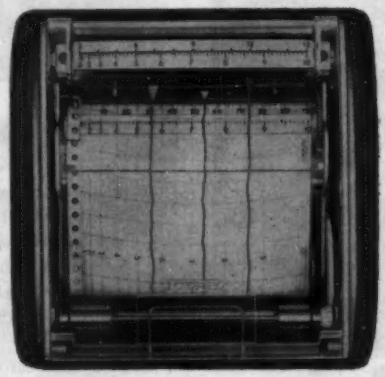


Same Chart Monitors Three Measurements

For greater operating convenience, six new features have been added to the standard panel-type Consotrol instruments.

Two of these advances permit greater recorder flexibility. First, the Model 53 and Model 54 (pull-out) will accommodate three pens so that three measurements can be monitored on the same chart. Second, a Model 54 Consotrol recording control station can be tilt-mounted for use in console units.

Two automatic control developments extend the number of control actions available with the Model 58 Consotrol controller. In addition to proportional, reset and derivative, it is now possible to achieve Batch Stabilog and Auto-Selector actions. Batch Stabilog control permits the use of reset action on batch processes without "wind up" or "overshooting" at the start of an operating cycle. Patented Auto-Selector action provides a smooth transfer of reset control selectively for any number of related variables.

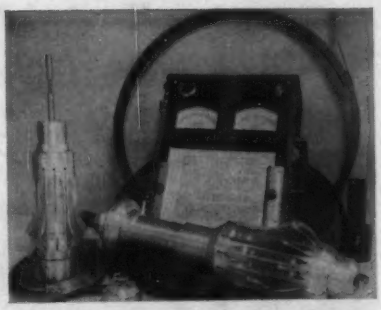
A new type chart tear-off bar and a new automatic-manual switch handle are standard with each instrument, while all other new operating features are available as optional equipment. The Foxboro Co.

Circle E17—green card, last page

Booklet Covers Use of Welding Inserts

A new 12-page booklet contains information to help welders, welding engineers, chemical construction contractors and metal fabricators obtain a sound root pass weld with the aid of a consumable insert when only one side of the weld is accessible.

The booklet compares conventional



Roberts **Electrical Tube Caliper**

Provides continuous and accurate measurements of the I.D. of heater tubes of any length.

Locates and indicates the depth of cleaner rings and pits.

Can be used to measure the thickness of coke and scale formations.

Interchangeable heads cover the range between 1.40" and 8.00" diameter.

Portable, rugged, fast and convenient. Requires only a lighting circuit connection.

Supplied in four basic types as three point gages for horizontal or vertical tubes, as eight or twelve point gages indicating the maximum of four or six diameters and as dual meter, eight or twelve point gages indicating minimum and maximum diameters and thereby the depth of pits.

Has had up to twelve years of oil refinery service in ten countries. Write, wire or phone:

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412 HARRISON ST. RIDLEY PARK, PA.

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THE "pro" OF proper PRODUCTS

There's nothing amateurish about the way Plibrico refractories get the job done. That's because there are no cure-all refractories in the Plibrico line, but rather specific types and grades tailored to lining process equipment.

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Plicast Verilite—a light weight insulating castable of unusual characteristics, combining low "K" factor and utmost strength. Made for pneumatic application.

Plicast Petromix (Tuff-Mix G)—a first quality dense castable specifically designed for early strength in the intermediate temperature range (1000-1500 deg. F.), and for pneumatic application.

Plicast 40—one of seven abrasion resistant castables. Designed for low iron service requirements in extreme conditions. For trowel or pneumatic application.

Ask your Plibrico man for complete details. Write, too, for our catalog covering your applications.

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So SIMPLE that "Specials" are Likely to be Standard!

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LIQUID LEVEL CONTROL

Because of the utter simplicity of Magnetrol's magnetic operating principle, standard models can be easily adapted to meet any special requirements for pressure, temperature or corrosive liquids . . . and usually at little extra cost. This Magnetrol versatility has solved all kinds of tough level control problems . . . and given our engineers wide application experience that can be invaluable to you.

Magnetrol is so simple that failure is all but impossible! Using only permanent, unfailing magnetic force for its operation, there's nothing to wear out . . . no diaphragms or bellows to stiffen and rupture . . . no electrodes to short or corrode . . . no packing to bind or leak. Magnetrol is practically maintenance-free! Magnetrol units are available for controlling level changes from .0025-in. to 150-ft. . . . with multi-stage switching when desired. Send coupon for full details.

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Please send me catalog data and full information on Magnetrol Liquid Level Controls.

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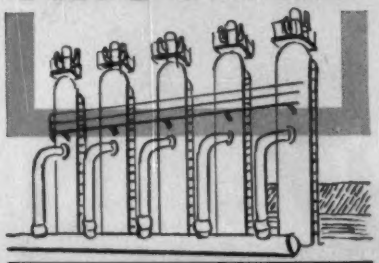
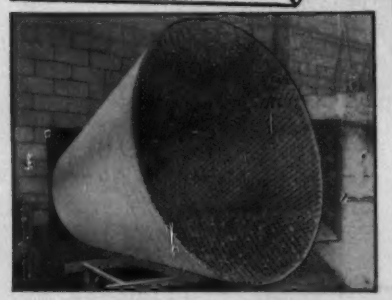
FEWER "TURN-AROUNDS"





Shutdowns for repairs of fire clay linings in refractory units are expensive. The frequency and duration of these shutdowns can be greatly reduced by the use of a steel grating armor known as "Gridsteel", which holds the castable refractory linings in place longer and armors them against the bombardment of catalytic elements.

"Gridsteel" is available in a special loose clinch to conform easily to curved surfaces.

For complete information, write for brochure on Irving "Gridsteel" Contour Retainer Mesh

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New Equipment . . .

methods of producing a root pass to the use of consumable EB weld inserts. Fifteen different insert compositions are classified for the welding of carbon steels, austenitic stainless steels, non-ferrous alloys and chrome-moly and chrome steels.

One section deals with joint design for varying wall thickness. Placement of the EB weld insert for a typical butt weld is diagramed. Extensive treatment is given to root pass welding procedures including tack welding for positioning, gas protection of the inner surface, root pass inspection and completion of the weld. A chart lists recommended filler rods. Also included is data on the dimensions of welded and seamless steel pipe and specifications for austenitic stainless steel pipe of both welded and seamless versions. Arcos Corp.

Circle E18—green card, last page

Changes In Desuperheater Design Explained In Bulletin

An innovational change in desuperheater design is described in a recently published bulletin. Clear schematic illustrations and explanatory text outline the working principle of this advanced thermodynamic design.

Also presented are complete specifications, constructional design features, and a hook-up showing the new Variable Orifice desuperheater in use with a pressure-reducing station. Blaw-Knox Co.

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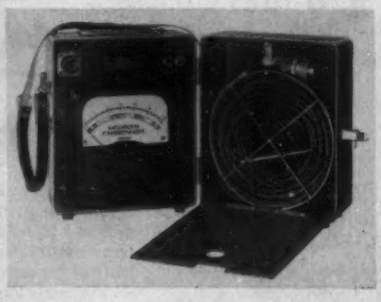

Resistance Thermometer Gives Spot Temperatures

To provide a quick, accurate means of securing spot temperatures of petroleum products, chemicals and other fluids in barges, rail or sea tankers, mobile or stationary tanks, etc., the company has just introduced a new portable resistance thermometer approved by Underwriters Laboratories for use in hazardous locations. Known as Model 917 the thermometer consists of a two-range temperature indicating instrument, a Resistance Bulb with a 60 foot Connecting Cable and Plug Connector, Range Changing Switch, non-locking type Power Switch, a six volt dry cell battery, and a spring-actuated grounding terminal. A bulb weight and protector is available as an accessory. The indicating instrument is furnished with a two-range scale such as —20 F to +100 F, and +60 F to 180 F, giving each scale a span of 120 F. Other range combinations also are available. Temperature Compensation for ambient temperature changes, over the range of 0 F to 150 F, gives the

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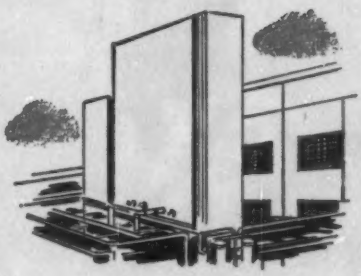
CO

Now you can produce CO more efficiently, simply, at lower cost

LONG THE BANE OF many chemical processes, carbon monoxide has suddenly become one of the most valuable raw materials of the ever-growing plastics and allied industries. More important still is its method of production by low-temperature gas separation, in which techniques perfected by Air Liquide during the past 50 years have resulted in unprecedented efficiency, tremendous economies and maximum purity.



Leading this highly specialized field in the United States, Air Liquide low-temperature gas separation plants, the first to be built in this country for the production of pure CO, have recently been completed in four widely separated locations, and a fifth is under construction.

Our entire technical and manufacturing staff, including design, process, project and mechanical engineers, backed by a half century of world-wide experience, is at your service to assist you in applying low-temperature technology to your particular needs — whether your product requirements are carbon monoxide, oxygen, nitrogen, hydrogen or other gases, or a solution to purification problems.

We shall be glad to consult with you regarding cost analyses and technical aspects in the design and manufacture of complete plants or components especially fitted to your needs. Write today for complete technical information on our CO plants.

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Here are the results of tests to determine the number of pipe joint threads that can be coated with Rectorseal and other compounds. Rectorseal coated ⅓ MORE joints than the nearest competitive brand; and 2⅓ times more than another brand.

Brand	Number of 2" pipe joints coated, per pint.
RECTORSEAL	448
Brand "A"	192
Brand "B"	224
Brand "C"	336

Start using Rectorseal now—be sure of leakproof joints, and get more seals per dollar for economy.

Rectorseal No. 2
—Dries fast
—Sets soft.

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—Dries slow
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Both can be used for the same services. Specify your preference when writing for sample.

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RECTORSEAL

THE POSITIVE LEAK PREVENTER

New Equipment . . .

instrument and accuracy of plus or minus one percent of the scale span. To clearly show the length of cable immersed at points where temperature measurements are taken, the cable has clearly numbered brass markers at five foot intervals. The unit is housed in a sturdy compact metal carrying case with handle as well as with a detachable leather shoulder strap. Weston Electrical Instrument Corp.

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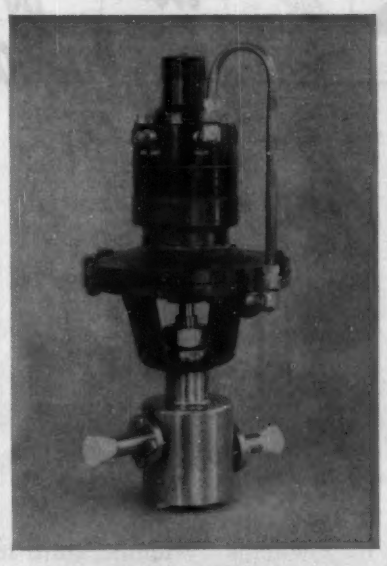


Control Valve Internals Machined From Teflon

To assist in controlling the flow of a corrosive product, a control valve that safeguards the product and itself with Teflon is now available.

The body, stuffing box, integral seat and internal ports are all precision machined from a solid block of Teflon, and encased in a stainless steel housing. The plug and stem are one, machined from Teflon and reinforced with stainless steel. Spring loaded Teflon chevron rings maintain a tight stem seal.

The plug may be calibrated within the range of 0.003 to 1.4 Cv, with a maximum rangeability of 50 to 1. George W. Dahl Co., Inc.

Circle E21 green card, last page

High Temperature Teflon Resin Now Available

Announcing limited production of the new du Pont thermoplastics Teflon 100-X perfluorocarbon resin.

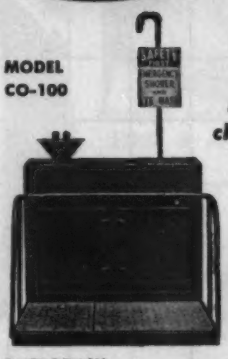
Products made from 100-X have essentially the same outstanding electrical, chemical and mechanical properties as other Teflon resins, except for maximum service temperature. Top service limit for 100-X is about 400 F., making it by far the highest temperature true thermoplastic material.

Among new extruded products from 100-X to be offered are: mono-filaments from 5 mils, rods to 2 inch dia.; tubing from 10 mils O.D. to three-eighths inch

MORLAND

. . . geared to produce hard-to-find specialties for oil refineries and chemical plants

MODEL CO-100



EMERGENCY SAFETY SHOWER

Combination non-freezing overhead shower and eye bubbler independently activated by aluminum platform treadles.

Above—Spade Flange, Spacer Ring and Figure "8" for raised face flanges. Also made in ring type joint style in all metals and pipe sizes.

Write for illustrated folder showing other showers, strainers, figure "8's", retractable spray nozzle assemblies, etc.

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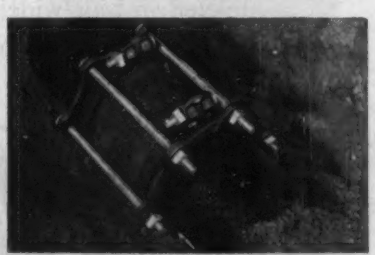
REPAIR LEAKS

QUICKLY—PERMANENTLY

SKINNER-SEAL PIPE JOINT CLAMPS stop leaks at joints. Put on under pressure—without interruption of service. Quick, simple, lasting repair. Sizes 1/2" to 24" incl. in stock.



SKINNER-SEAL COLLAR LEAK CLAMP—designed to stop every type of collar leak in oil and gas lines. Sizes: 2" to 13" inclusive.

M. B. SKINNER COMPANY

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ABCO PREFABRICATED INSULATION FITTINGS*

FOR

HI-TEMP LOW-TEMP SERVICES

Get fast application, with lower long range maintenance costs, and less stocking problems by using ABCO prefabricated insulation fittings.

ABCO fittings are removable and replaceable, and reduce deterioration caused by moisture in joint cracks. Finished installation is made at the same time as other insulation without slowdown, scaffolding tie-up or the usual insulation accessory mess.

Plan today to replace worn-out fitting insulation the modern way—with ABCO Prefabricated Fittings.

*"Uni-Ells", "Uni-Tees", "Uni-Flanges", "Uni-Valves", "Uni-Bends" and Vessel Covers

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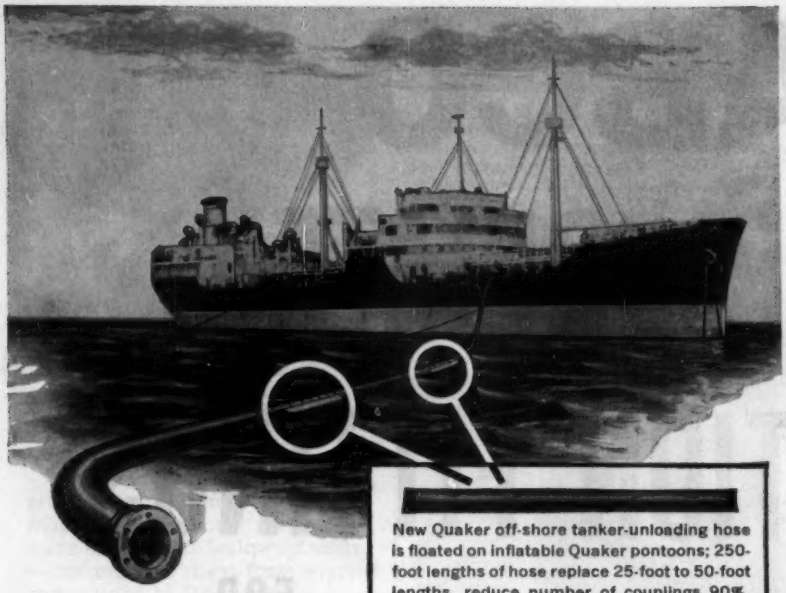

New Quaker off-shore tanker-unloading hose is floated on inflatable Quaker pontoons; 250-foot lengths of hose replace 25-foot to 50-foot lengths, reduce number of couplings 90%.

SMART WAY TO FLOAT SHIP-TO-SHORE HOSE:

Use this Quaker floater rig

The old nuisance of floating ship-to-shore oil hose on empty drums is finally licked. And Quaker licked it.

Now, with Quaker's new floater assembly, you do away with bulky, abrasive 55-gallon-drum pontoons . . . you reduce the number of hose couplings as much as 90% . . . and you make the loading or unloading of a tanker off shore a relatively simple job.

This assembly consists of a reel that propels 250-foot lengths of Quaker hose to or from the ship, floated on revolutionary *inflatable* Quaker pontoons which, deflated, take up only a quarter of the space once needed to store inconvenient, rustable metal drums.

It's a beauty of a time- and money-saver! Find out more about the Quaker-Porter Floater Hose Installation. Ask your Quaker industrial distributor for full information, or write *Quaker Rubber Division, H. K. Porter Company, Inc.; Philadelphia 24, Pa., or Pittsburg, California.*

19-foot Quaker pontoon hose folds up into less than ¼ the space taken up by drum.

H. K. PORTER COMPANY, INC.

QUAKER RUBBER DIVISION

New Equipment . . .

O.D. with wall thicknesses of a few mils up, depending upon tubing size; high grade electrical tape from one-half mil to one-sixteenth inch in thicknesses, and in continuous widths up to 24 inches. (Tapes up to 10 mils thickness are transparent and even as high as 50 mils are still only slightly translucent.) Thermoplasticity of 100-X eliminates voids and accounts for the unusually high dielectric quality of the tape.

Tapes also may be heat bonded to various substrates such as steel and aluminum and may be heat sealed to produce continuous, chemically impervious linings and facings for chemical tanks and other equipment. United States Gasket, Plastics Division of the Garlock Packing Co.

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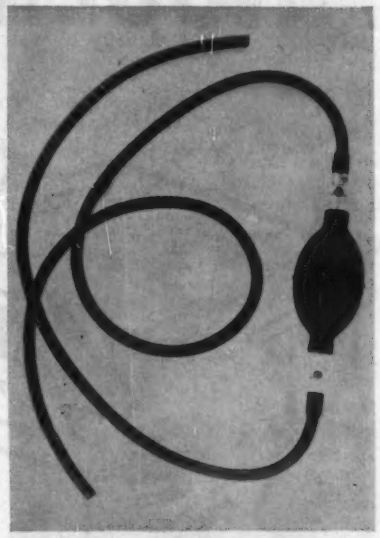


Dangerous Liquids Handled Easily With Siphon-Pump

A new hand-operated, self-starting siphon-pump, designed for the safe handling of concentrated acids, has just been developed.

The siphon-pump, called Model P, has newly developed check valves of duPont "Alathon," a compound which is unaffected by concentrated hydrochloric, sulfuric and hydrofluoric acids (at room temperature) as well as alcohols, gasoline and most industrial solvents. Hand bulb and tubing are of neoprene.

A full seven feet long, the siphon-pump permits speedy transfer of dangerous liquids with complete operator safety. General Scientific Equipment Co.

Circle E23 green card, last page

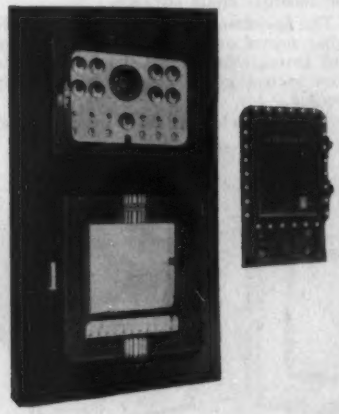
Gages and Valves Are Completely Rustproofed

Liquid level gages and valves are now completely rustproofed inside and out as standard practice. Through a special chemical process the gages and valves are rustproofed, thus reducing maintenance expense and troubles from paint chipping and frozen connections due to rusted

New Equipment...

threads. Gages are rustproofed with a gray color on the covers, a black color on the liquid chambers; valves are rustproofed in a gray color. Painting is not necessary for rust prevention; however, when a plant uses color painting for identification of equipment the rustproofing process used presents a crystalline type surface with sufficient tooth so that paint naturally adheres thus making painting quicker and easier with longer life potential. Jerguson Gage & Valve Co.

Circle E24 green card, last page



Instrument Can Analyze Four Process Streams

The ultimate in Gas Chromatography instrumentation, the new "Chromomax" Analyzer, has just been announced. This new instrument can analyze as many as four process streams containing natural gases, vapors, low boiling point liquids and hydrocarbons, with eight such components in each stream.

The "Chromomax" instrument assembly consists of an explosion-proof Analyzer Unit, a Programming Unit and a Speed-

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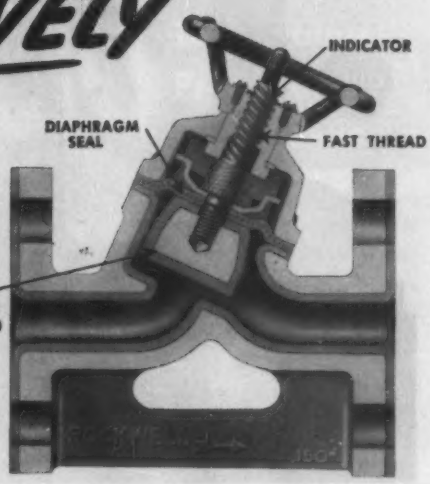

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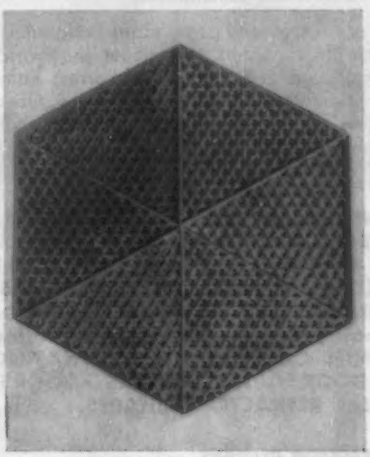

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LOW HOLDUP

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Forty-eight NATIONAL AIROIL Tandem Units fire Gulf's huge Crude Heater at Philadelphia.

with NATIONAL AIROIL'S

Exclusive TANDEM COMBUSTION UNITS

This tremendous Combination Atmospheric—Vacuum Crude Heater at Gulf Oil Corporation's Philadelphia Refinery, was constructed by Foster Wheeler Corporation . . . for a total burner liberation of up to 600,000,000 B.T.U.'s per hour.

NATIONAL AIROIL exclusive Tandem Combustion Units achieve this capacity with maximum economy and availability.

These NATIONAL AIROIL oil burners are all-alloy for burning high temperature pitch separately, or in conjunction with non-aerated gas burners. Additional burners are also provided for waste gas disposal.

NATIONAL AIROIL Tandem Units are recognized as standard firing equipment in oil refinery and chemical plant heaters throughout the world. They are noted for versatility regarding fuels; and insure correct flame placement so necessary to avoid damage to the heat-absorbing tubes. Your furnace maintenance problems are measurably reduced, and hours on stream greatly increased by use of Tandem Combustion Units.

Further information sent upon request on your letterhead.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes; STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS, for small process furnaces and heating plants; FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.

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INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

New Equipment . . .

omax G Recorder. Extensive use of items such as plug-in components provide minimum downtime and low maintenance.

The Analyzer unit provides: temperature control of the analyzer unit itself from 50 to 120 C with accuracy of better than ±0.1 C in the presence of ambient swings as great as 60 F; an air circulation system without blower motors; and detectors consisting of special low volume cells with hot wire filaments.

The Programming unit provides: complete controls to perform an analysis; continuous peak attenuation of each component being measured; and activation of the recorder chart advance.

The Speedomax G Recorder draws either a bar record or a spectrum of an analysis, and automatically zeros the bridge circuit after each analysis cycle. Leeds & Northrup Co.

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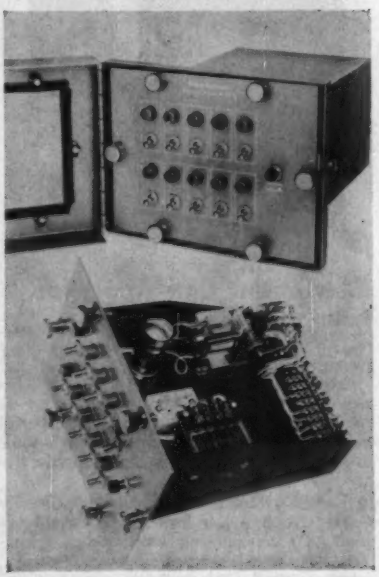

Monitor Two Streams With Automatic Stream Selector

The availability of an Automatic Stream Selector has been announced by the company.

When used in conjunction with the company's industrial chromatographs, the stream selector makes possible the con-

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New Equipment . . .

secutive monitoring of two or more identical streams such as those found in the chemical and petroleum industries. A series of numbered lamps (photo) indicate by the intensity of their color what streams are included in the chromatographic system, what streams are being monitored, and the particular system being analyzed at the moment. The stream selector may be set for automatic or manual operation by use of a manual advance button located on the panel. Its operation is based on the control of a manifold consisting of solenoid valves. Beckman Instruments, Inc.

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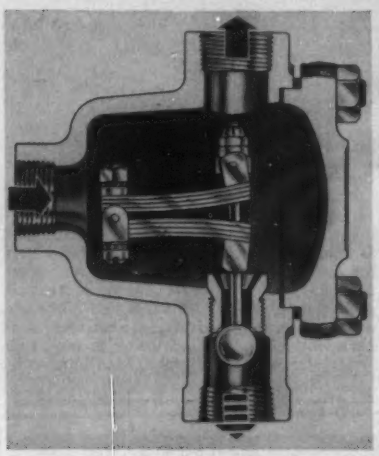

Guard Condensate Lines With Freeze Protector

Announcing the addition of a needed safety device to protect condensate lines in cold weather, where temporary pressure failure can mean freeze ups, broken lines and lost production time.

The Freeze Protector consists of a specially designed bi-metal element in a forged steel body with all stainless steel trim and stellited valve seat. It is installed in the low points of return mains or before risers and the normal temperature of the condensate keeps the valve closed. In the event of boiler pressure failure or line blockage, the resulting temperature drop will cause the element to open the valve to atmosphere at a predetemined temperature of 90 to 120F. The one-half inch orifice has sufficient capacity to drain the lines quickly before freezing can take place.

This highly dependable method of line

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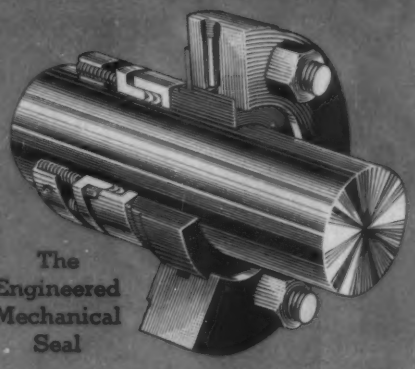

The Engineered Mechanical Seal

Because Dura Seal rotary mechanical seals are made of any machineable metal alloy, they are engineered to provide perfect sealing in the presence of highly corrosive process fluids at high speeds, pressures and temperatures.

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INCREASE the life and efficiency of heat exchanger tubing with ALUMI-SPRA.

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ALUMI-SPRA on the effluent side of exchanger tubing will solve your sulphide scale fouling problems.

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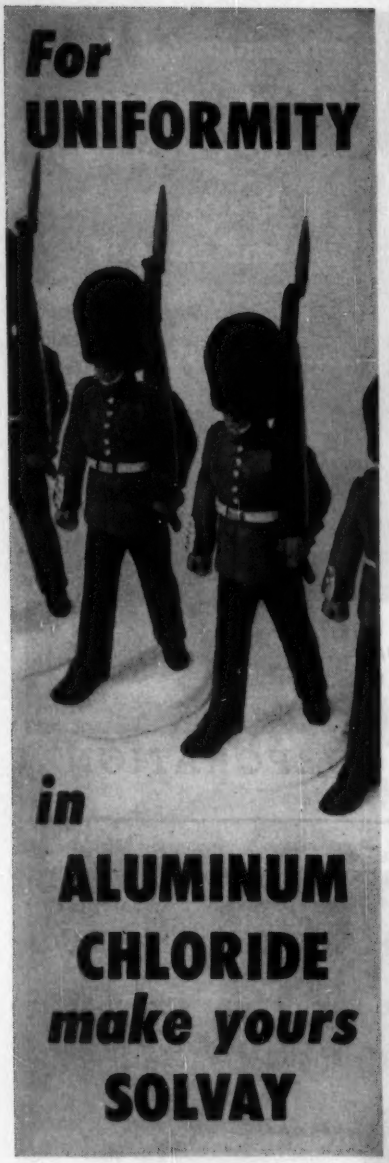

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protection at a minimum of initial cost, can save untold amounts of money by preventing costly freeze ups in Oil Refineries, Chemical Plants, or any condensate system exposed to freezing.

The Freeze Protector is installed in the line as a standard pipe fitting with no additional piping required and is stocked in ½-inch, ¾-inch, 1-inch connections with larger sizes also available on request. Velan Steam Specialties, Inc.

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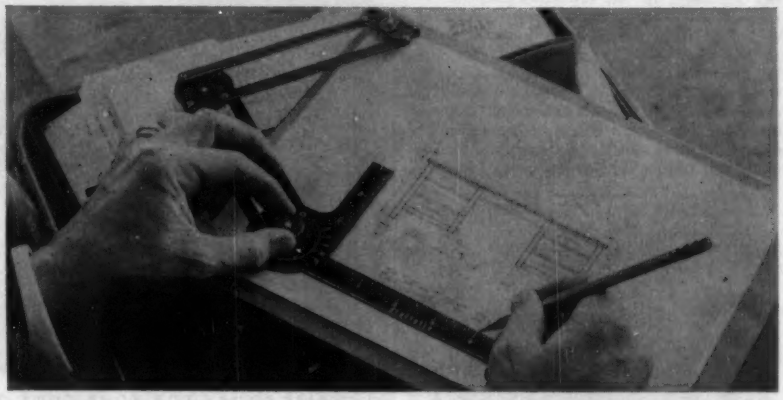
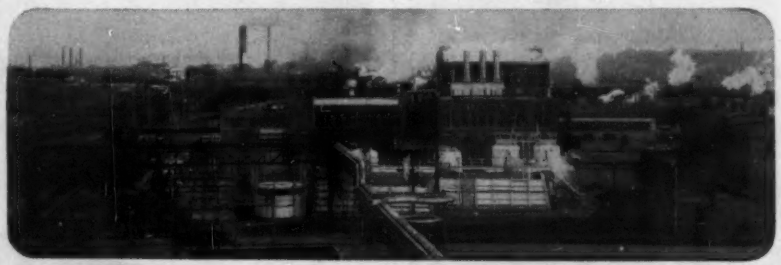


Portable Drafting Machine Fits Easily in Briefcase

A new-design portable drafting machine, so compact that it can be folded jackknife-style to fit in the pocket when detached from its drawing board, has just been introduced.

Called "Draftette," the precision instrument, in its new design, is now available attached to a portable drawing board that fits easily into a briefcase. The unit takes the place of T-square, ruler, protractor and triangles. It is suggested for use wherever drawing, drafting, sketching and designing with high accuracy is required.

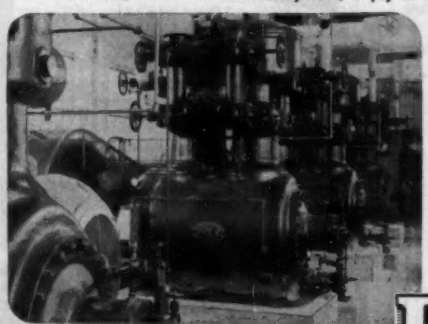
"Draftette" is of all aluminum con-



GOODYEAR'S NEW CHEMIGUM PLANT EQUIPPED WITH FRICK REFRIGERATION

This versatile plant, just completed at Akron, makes many types of rubber, latices and plastics. The big reactors, each holding 3000 gallons, are lined with glass; each is cooled with seven banks of glass-coated ammonia coils of the patented Frick direct-expansion design.

These coils, with their control system, enjoy a world-wide preference for use in chemical reactors.



Frick ammonia compressors at Goodyear's new plant in Akron, Ohio.

Four Frick compressors of 12 in. bore and 12 in. stroke, together with a 5 by 5 machine, carry the refrigerating load under automatic and semi-automatic controls.

When you want the most durable and efficient refrigerating equipment, whether for air conditioning, process work, ice making, quick freezing or other cooling service, specify "Frick". Literature and estimates on request.

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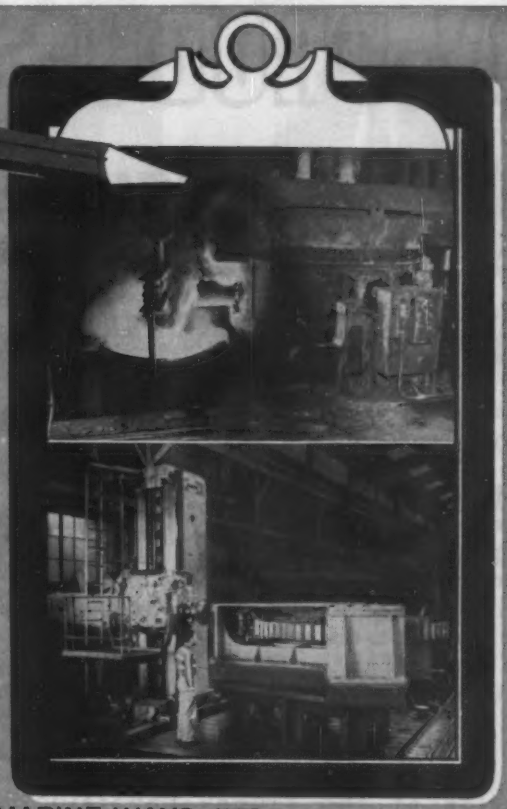

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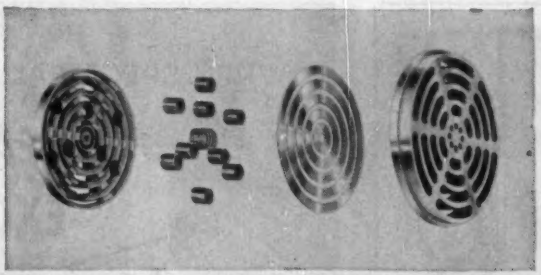

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- up to 40% more valve area • minimum pressure loss • higher efficiency
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Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

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struction, anodized jet black with gleaming white-filled numbers and letters of the scale and 180-degree protractor. Use of aluminum accents the lightness, long life and dimensional stability of the unit. David Miller & Associates.

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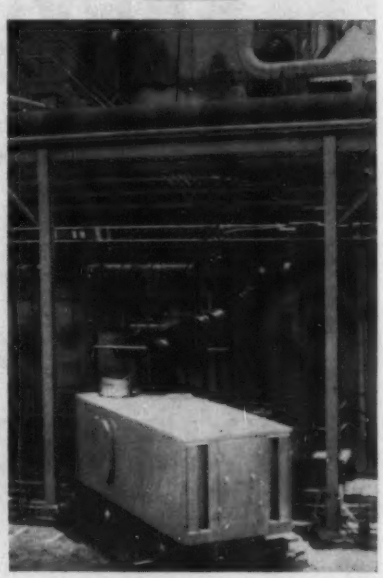

Portable Air Conditioner Cools Furnace for Repair

Shown is a 40 ton portable ice air conditioner in operation at a chemical plant in Eastern Texas. The unit is designed to provide inexpensive high tonnage for cooling down heated vessels rapidly and to provide an efficient atmosphere for workers in high temperature areas. It is reported by the manufacturers that they will cool heaters, furnaces, towers and boilers in 10 to 30 percent of the time required using normal outside air. It is also stated that reducing the interior temperature while workers are performing necessary maintenance and repair work from 120 or 130 degrees to 72 degrees will greatly increase efficiency and improve morale. An efficiency increase of 100 percent is not uncommon.

These units are available in sizes—20, 30, 40, 50 and 60 tons. The units may also be used as blowers, dehumidifiers, and with a slight modification, portable heaters. Ready Cool Division of South House, Inc.

Circle E29 green card, last page

Steam Ejector Bulletin Covers Dalton's Law

An interesting bulletin on a new line of Steam Jet Ejectors has just been issued.

The bulletin describes the ejectors which are available in a wide range of sizes with single and multiple stages up to six stages. These ejectors are designed to meet the vacuum requirements of the power and process industries.

Of particular interest to most engineers

New Equipment . . .

will be the two Dalton's Law Charts contained in the bulletin. These give the percent air in an air-water vapor mixture for various temperatures at various absolute pressures. This entirely new plot of the relationship provides a valuable tool for all types of engineers; particularly in the solution of Dalton's Law problems. Southwestern Engineering Co.

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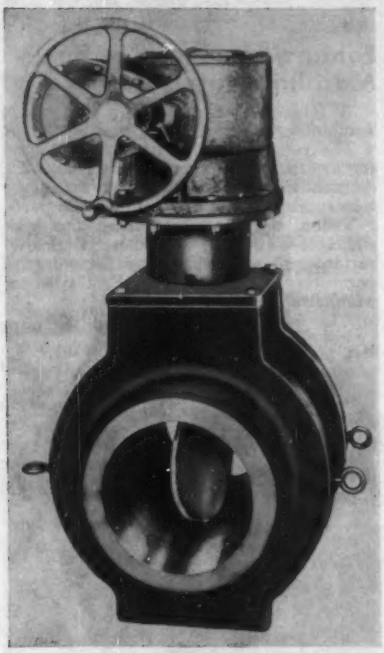


Butterfly Valve For Use In High Pressure Service

This 14 inch alloy steel R-S butterfly valve is particularly adaptable for regulating service in the process industries. An outstanding feature of this model is the unusually high pressure service not formerly associated with this type of valve.

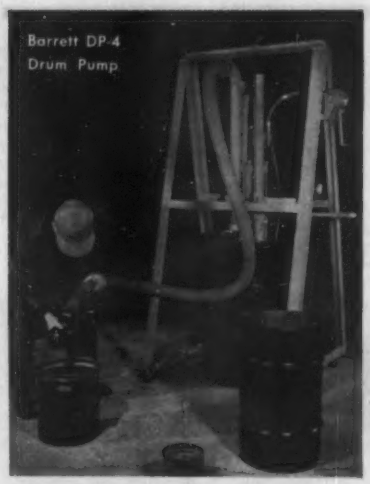
This 2500-pound valve, equipped with welding ends and manual control, is designed for service at 2630 PSIG, with a working pressure at 450 F. S. Morgan Smith Co.

Circle E31 green card, last page

Pump Line Has Major Parts Interchangeable

A new line of 21 pumps is divided into four size groups having 20 major parts interchangeable within each group. The new single stage pumps feature a double wearing ring impeller, angular contact thrust bearings, a mechanical seal or conventional packing. The rotating element—shaft, shaft sleeve, impeller, wearing rings, head, packing gland, bearings and housings—form a completely unitized assembly. This simplified design provides rapid dismantling and reassembly, and reduces maintenance costs.

Developed for economical transfer of hydrocarbons, chemical solutions, acids,



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and condensates, the SVA pump has a capacity of 15 to 1600 GPH at a working pressure of 500 psig, a differential head of 700 feet, speeds of 3600 RPM and temperatures to 300 F.

Radially split case; dynamically and hydraulically balanced impellers; one piece head and packing box; precision fit shaft and sleeve, and wide range of materials are additional features of the new line of SVA pumps. Pacific Pumps, Inc.

Circle E32 green card, last page

Folder Describes Custom Machining of Teflon

A folder showing facilities for custom machining Teflon parts is now available.

The two-color publication also displays the assortment of types of components the division makes of Teflon and states the tolerances that can be held on these parts.

Teflon, or tetrafluorethylene, has high chemical resistivity, an almost frictionless surface and an ability to withstand temperatures as high as 500 F. Raybestos-Manhattan.

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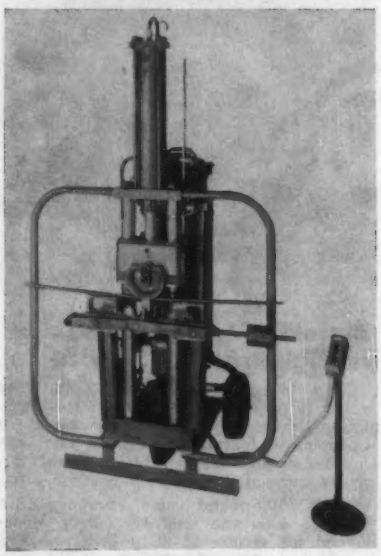

Portable Bender For Crowded Shop Use

A new vertical ram type bender has been developed for press bending. It accomplishes two things—saves space (floor space measure 100 x 45 inches) and makes for easier handling of material being bent.

It bends to 180 degrees with no reposition of dies or relocating of material, bending up to two inch heavyweight steel pipe. Coils, return bends, special curves, angle irons, channels, reinforcing bars, flat bars, etc. can be bent on this machine.

A motor-driven hydraulic pump is mounted on an oil reservoir forming a part of the machine's structural frame. The pump supplies pressure under push-button control to a cylinder. This cylinder carries the ram for the sliding head that

is carried on vertical bar-type ways. The head mounts the central bending die between two side dies carried by heads pivoted at the base of the bender for varying width or radius adjustment. The side dies rotate on studs on these arms as a single stationary die secured centrally takes their place. Wallace Suppliers Mfg. Co.

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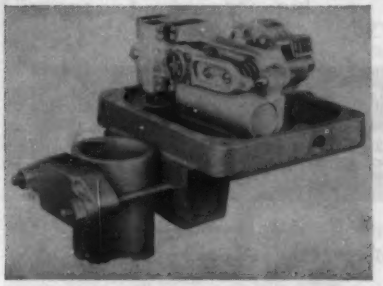

Compact Designed Pressure Temperature Transmitter

A new, compactly designed temperature and pressure transmitter has just been announced. These transmitters are pneumatic force-balance devices employing gas filled thermal systems for temperature measurement and bellows elements for pressure.

One outstanding feature is said to be their "Balanced Beam" design which permits mounting of the transmitter in any position without positional error.

Also provided are a number of exclusive operating advantages in the compact and unusually rugged design. Unit subassembly construction is used throughout, permitting removal of sub-assemblies without disturbing beam assembly. Thermal systems and pressure elements are readily removed for change of range span. A derivative unit, which compensates for lags in the thermal system, can be quickly added on the underside of the baseplate, and requires no tubing or fittings. There is also a special provision for an integral Receiver Gage to be mounted directly on the baseplate, without external connections. Mason-Neilan division Worthington Corp.

Circle E35 green card, last page

All-Plastic Strainer For Corrosive Materials

The first all-plastic, Y-sediment strainer has just been introduced. Made of highly corrosion resistant, rigid polyvinyl chloride, the new strainer is designed for service on alkalis, acids, inorganic salt solutions and other corrosive materials.

Strainer is of rigid PVC sheet with one-thirty-second inch holes. Open area of the perforated screen is at least twice the cross sectional area of corresponding Schedule 80 pipe, thus assuring adequate flow.

Light in weight, the strainer is easily handled and installed. The screen, which

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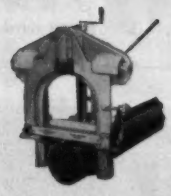

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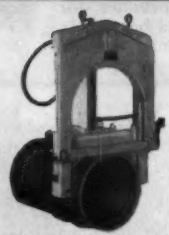

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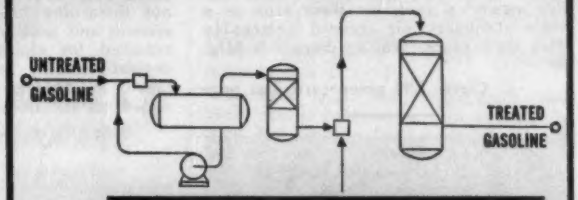

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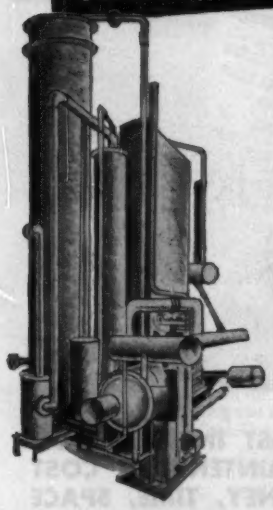
NITROGEN GENERATORS



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Be sure to get full details on STRAUB Nitrogen Generators—built in a standard range of capacities from 1500 to 20,000 C.F.H. Larger and smaller sizes are also available.

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LIGHT PORTABLE TOOL BENDS 8" PIPE 90°

TAKES ONLY 3 MIN. WITH 2 HP MOTOR

ALSO USES ½ HP MOTOR OR GASOLINE MOTOR

- **EASY TO USE**—Quickly set up for pipe size and bend desired. Quick-releasing bending shoes. Bend indicator.
- **EASY TO MOVE**—Swiveling casters. Frame folds back for compact storage. Simple sections are quickly dismantled.
- **FAST and POWERFUL**—Hydraulic cylinder has 4½" bore and 60" ram travel. Pump develops up to 10,000 p.s.i.
- **SMALL and LIGHT**—By far the smallest, lightest, most economical bender available in this capacity.

SAVE UP TO 90% on piping jobs! Minimize pipe cutting and welding time . . . save cost of elbows!

You can make perfect, wrinkle-free bends . . . on the job or in the shop . . . with this low-cost hydraulic tool. Bends made cold, in just one setting. No filling.

Interchangeable parts handle ⅜" to 8" pipe, X or XX. 8" XX pipe bent 90° in only 3 min. when using 2 hp. motor. Also operates with ½ hp. motor or gasoline engine.

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DEPT. 33
MILWAUKEE 2, WIS.

is welded to the strainer cap, is merely unscrewed for cleaning.

The new PVC strainer has a service rating of 150 psi at 75 F and psi at 150 F. It is available with either threaded, solvent-weld socket-type or flanged ends, and comes in five sizes from one-half through two inches. Walworth Co.

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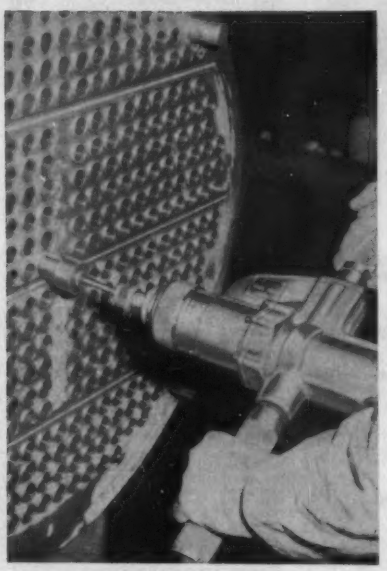

Tube Rolling Tool Speeds Job—12 Tubes Per Minute

An entirely new concept in tube expansion control equipment has recently been made with the introduction of a uniquely designed, pneumatically operated tube expansion control.

This new precision instrument automatically controls tube expansion by accurate measurement of torque, rolling up to 12 tubes per minute to uniform accuracy.

Accurate to within .001 of an inch, the tool automatically stops expansion according to a predetermined setting. This results in uniformly tight tube joints with no over expansion or under expansion. This extreme accuracy is obtained through the sturdy, torque sensing mechanism which is entirely unaffected by fluctuations in air pressure.

A primary benefit of the tool is that it positively insures maximum tightness and holding strength in every tube joint in the condenser or heat exchanger, and also prevents distortion or breakage of ligaments in the tube sheets.

Airetrol's finger-tip micrometer adjustment is quickly set to the desired torque without using any tool, and the calibrated ring permits setting as low as 0.5 foot pounds and up to 37 foot pounds torque at 90 p.s.i. Airetool Manufacturing Co.

Circle E37 green card, last page

Stainless Steel Fittings For Services To 2500 PSI

A complete standard line of cast stainless steel fittings designed for services to 2500 PSI at 670 F has just been announced.

These fittings, available in both the 300 and 400 alloy series stainless steel, in sizes 8 inches to 30 inches include 45-degree and 90-degree elbows, tees and reducing fittings. They meet the strict quality controls required for nuclear applications as well as those in the chemical and petrochemical industries. Cooper Alloy Corp.

Circle E38 green card, last page

New Equipment . . .

Anti-Icing Compound More Effective Than Alcohol

Announcing the commercial availability of an entirely new anti-icing compound—Unicor-LHS—which prevents ice formation much more effectively and economically in severe carburetor icing conditions than the widely used alcohol type.

The new compound is completely and instantly miscible in even the lightest components of high vapor pressure wintergrade gasolines, the company said. Moreover, the new anti-icing agent has detergent properties which enable it in comparatively low concentration to keep automobile fuel induction systems clean.

The company said since only small amounts of Unicor-LHS are required, large scale storage and blending facilities are not needed, and the new anti-icing agent can be applied anywhere from refinery to service station.

Additional tests have shown Unicor-LHS to be an exceptionally effective rust and corrosion preventative for use in refinery processing equipment, distribution, and storage facilities. Universal Oil Products Co.

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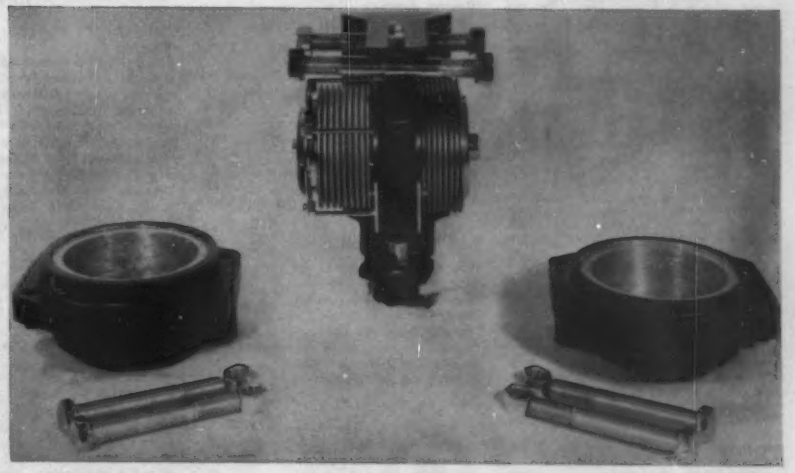

Bellows-Type Flow Meter Is Extremely Accurate

A bellows-type flow meter accurate to within one-half of one per cent and designed primarily for the oil and chemical industries has just been developed.

The differential pressure measuring device, according to the company's engineers, maintains this accuracy even when ambient temperature changes by as much as 100 F. and static pressure reaches 2500 psi.

In operation, differential pressure is applied to the bellows unit through high and low connections. As the differential pressure changes, the liquid fill in the bellows unit moves from high to the low pressure side, or vice verse, changing the tension of the range spring. This moves the bellows connecting rod, repositioning the torque tube arm. The torque tube shaft is connected to the transmitter unit so that a change in differential pressure changes the transmitter output.

Range of the flow meter is easily changed in the field by springs available in 15 different ranges between 0-20 and 0-400 inches of water.

Other features of the new flow meter include a linear damping adjustment and an easily accessible external suppression adjustment for use when the meter body measures liquid level in closed tanks. Minneapolis-Honeywell Regulator Co.

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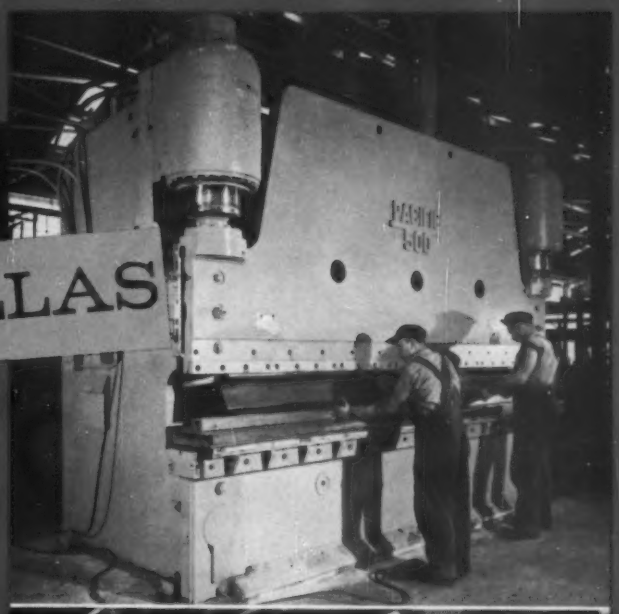

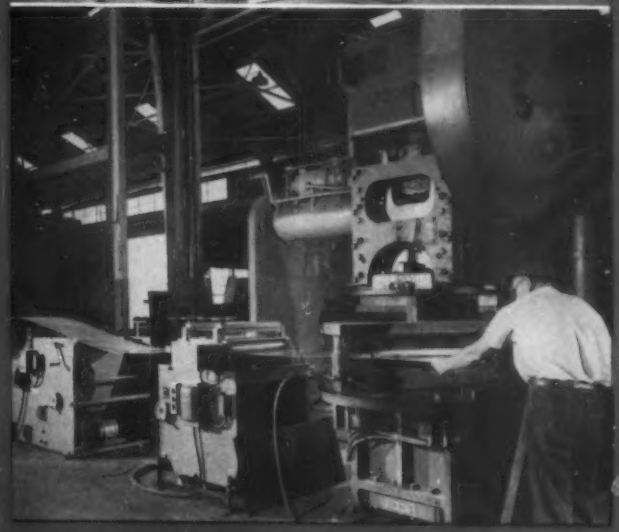

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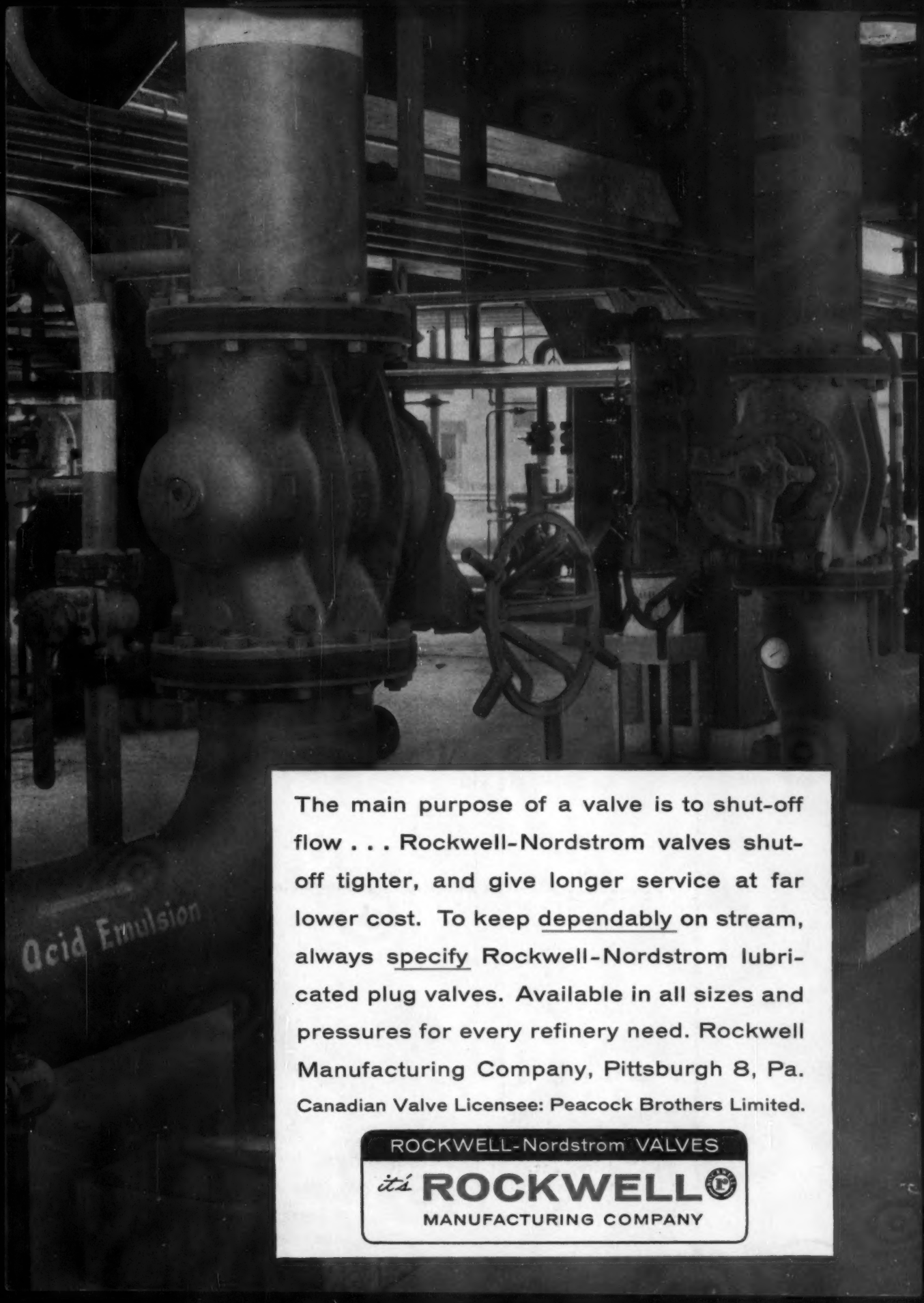

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